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THE RELATION OF CHRONIC MASTITIS TO CERTAIN HORMONES OF THE OVARY AND PITUITARY AND TO COINCIDENT GYNECOLOGICAL LESIONS

PART I—THEORETICAL CONSIDERATIONS AND HISTOLOGICAL STUDIES[1]

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THE relationship between the neoplasms of the breast and the glands of internal secretion has been the subject of study at the Memorial Hospital for a number of years. The first paper published in 1929 consisted in a collection of the older literature and an analysis of the clinical evidence of endocrine disease found in the histories and physical examinations of 271 patients with breast neoplasms. A second contribution in 1933 recorded further clinical observations in 101 cases of so called chronic mastitis, in particular the effects of treatment by pelvic operations, ovarian therapy, and radiation of the ovaries. In the present paper, based on the work of the last 2½ years, report will be made of a series of histological studies and the results of quantitative tests for certain hormones of the ovary and anterior pituitary made upon patients with various forms of generalized breast disease.

The diffuse breast conditions, commonly included in the term chronic mastitis, have been the special object of the present study, since these give at once greater indications of a constitutional or endocrinological basis than do the circumscribed tumors. The types selected have been three: the so called painful breast, certain forms of general hypertrophy, and the breast with abnormal secretion from the nipple.

The problem of the etiology of these conditions has been approached in three steps.

A. Their histology has been reviewed in the light of the histological changes now said to take place in the normal breast in relation to the menstrual cycle. For this purpose a new series of 41 sections of breast tissue obtained at known phases of the menstrual month has been collected and compared with histological sections from cases of diffuse breast disease.

B. A series of 261 cases divided among 183 with painful nodularity of the breasts, 31 with enlargement, and 47 with secretion has been clinically studied by gynecological history and examination and in part by actual observation of the uterus and its appendages at the time of operation for coincident pelvic disease. From data so obtained the cases have been classified in 8 groups, giving different degrees or types of endocrine disturbance.

C. Typical representatives of these groups have been selected for laboratory tests to show blood levels and rates of urinary excretion of estrin and prolan. The report on these biological studies and the clinical data noted in B are to be published in a succeeding number of this journal.

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Such a study of the relationship between these breast diseases and the perhaps analogous disorders in the female pelvis, with an investigation of the agents which may simultaneously affect or correlate the two areas, should be an important step in the constitutional study of mammary tumors. It has met great difficulties, however, in the existing lack of agreement upon the basic pathological process in the disease called chronic mastitis, in the incompletely understood significance of the associated gynecological conditions, and in the technical imperfections of the methods now available for the detection of minor variations in ovarian and anterior pituitary activity.

PREVIOUS EVIDENCE FOR AN ENDOCRINE FACTOR IN BREAST NEOPLASMS

In spite of the impression created by the recent outbreak of writing on the endocrinological aspects of breast disease, the belief in an ovarian or at least pelvic factor in the etiology of mammary tumors is not of recent origin. The theory has indeed developed along three rather definite lines of research, much of which has been recorded in the literature for some years.

A. Clinical recognition of a relationship between the pelvic organs and the breast has been built up by the careful observation of outstanding cases in which menstrual abnormalities or anatomical lesions in the pelvis were found in association with various forms of breast disease. Articles on this subject are found scattered throughout the last century and include the writings of Cooper (1829), Velpeau (1854), Witthauer (1902), and Miller (1925). The nature of the agent connecting the two regions was at first a matter of mere surmise, which has given way to a variety of theory with the discovery of the hormones.

B. Histological study has further developed the conception, for it has been possible to draw comparisons between the morphology of the abnormal hyperplastic processes in the human breast and other conditions in which a hormone cause is more readily provable. Examples which may be mentioned are the physiologically hyperplastic breast of pregnancy, the mammary glands of animals following treatment by certain hormones, and analogous processes elsewhere in the human body such as the well studied hyperplasia of the endometrium. An important and original contribution of this type was made by Moszkowicz (83–1927), but he has been followed by a number of others (Dietrich, Kueckens, Ingleby, Borchardt and Jaffé, Oliver and Major and Lewis and Geschickter). Each recent worker has shaped his views to fit conceptions, current at the time of his writing, of the hormone physiology of the breast.

C. Laboratory experiment has led to further important observations. Hypertrophy of the breasts in oophorectomized female animals or in males following the implantation of the ovaries or the injection of estrin was among the first described effects of the ovarian hormone (Steinach; Steinach and Dohrn; Laquer and co-workers; and Laqueur, de Jongh and Tausk). That this process may parallel a pathological condition in man has been suggested in the use of the term gynecomastia to describe the hypertrophy in the breast of the male monkey induced by the injection of estrin and anterior pituitary-like hormones (Geschickter, Lewis, and Hartman).

Breast conditions said to resemble Reclus' disease in their morphology have been produced in mice by Goormagtigh and Amerlink by injection of follicular hormone, and by Wieser by the use of several hormones alone or in combination, but especially by the corpus luteum. Similar effects have been brought about in rats by disturbing the estrus cycle by sterile coitus with vasectomized males (Ingleby). Evans and Simpson (36) have produced adenomas and fibro-adenomas by the continuous injection of anterior hypophyseal extracts, rich in growth hormone, into rats for long periods of time. Loeb (1919) and Cori (1927) noted that the incidence of hereditary mammary cancer in mice could be reduced by oophorectomy to a degree varying with the age at which the operation was undertaken. Murray has produced mammary cancer in male mice by ovarian implantation after removal of the testes, and Lacassagne by the injection of follicular hormone.

The search of the body fluids of tumor cases as well as the actual neoplastic tissue for

various hormones has resulted in another set of perhaps important, but often conflicting, observations. The presence of an anterior pituitary-like hormone in the blood and urine of patients with various genital tumors is now generally accepted. An increase of estrin in the urine of cases of granulosa cell tumors of the ovary (Schuschania, Bland and Goldstein), as well as in the blood of many types of malignant growth (Dingemanse, Freud, de Jongh and Laqueur) has also been noted. The presence of estrin in the tissue of mouse carcinoma and in certain gastro-intestinal cancers in man has been detected by Silberstein, Fellner, and Engel. Of particular interest to this work is the reporting during the last year by Geschickter, Lewis and Hartman of large quantities of estrin in the tissue of a fibroadenoma. The principle question of whether these substances are in some way connected with the production of the tumor or are simply the by-products of its cellular activity has received no final answer.

HORMONAL INFLUENCES ON THE DEVELOPMENT AND FUNCTION OF BREAST

The development of the breast has for a long time been referred to an ovarian activity and recently more specifically to an ovarian hormone. The earliest evidence was afforded by the failure of the breasts to develop in women whose ovaries were removed before puberty and their atrophy after oophorectomy and in the menopause. Early castration and ovarian implantation experiments in animals confirmed this relationship (Halban, 52; Knauer). In a later phase breast development was reported following the injection of various organ extracts which have now been shown to have contained the estrus producing or so called follicular hormone. With the development of the Allen-Doisy test for the recognition of the estrus hormone, a more definite relationship of breast development to this hormone has been possible and numerous workers have reported not only an enlargement of the gland structure, but of the nipples and areolæ as well, with injection of follicular hormone in a large series of animals, such as rabbits (Vitemberger; Turner and Frank 126); guinea pigs (Laqueur et al; Steinach et al; Champy and Keller; Haterius, 55; Loeb and Kountz); rats (Laqueur et al, Allen et al) and monkeys (Allen, E.). In women whose ovaries had previously been removed, Werner and Collier have reported activity in the breasts, characterized by a sensation of fulness and actual enlargement, tingling in the gland tree, and erection of the nipple after injections of theelin. A similar report was made by Loeser who, however, had used luteohormone in association with the folliculin. The latter observations stand in interesting contrast to the success reported in the treatment of the painful breast by ovarian residue and theelin (Cutler; Leriche, 72; Whitehouse).

That the estrus producing hormone or folliculin causes breast growth appears incontestable. Disagreement exists as to the extent of growth which it can produce. Laqueur and co-workers believe that in the guinea pig and rat it is possible to attain with the estrus hormone alone growth equal to that of pregnancy. Turner and Frank (127), on the other hand, assert that, in male and female castrated rabbits, the daily injection of the estrus hormone will cause a growth of the duct system of these glands equal to that produced during continued estrus but that greatly increased amounts of hormone will not carry the development beyond this stage. For further proliferation and formation of lobules characteristic of pregnancy or pseudopregnancy they believe a different agent is necessary. Vitemberger and Parkes (95) had also independently noted a limit to the development of the rabbit breast which could be produced by estrin alone. As the agent for this further development two additional hormones come into consideration, that of the corpus luteum and the anterior pituitary.

The relationship of physiological breast hypertrophy to the corpus luteum has long been accepted due to the striking simultaneous development of corpora lutea and the mammary gland in the pseudopregnant rabbit (Bouin and Ancel, Asdell and Salisbury), and by the development of the breast in association with persistent corpora lutea in several animals (Marshall and Halman, O'Donoghue Hammond and Marshall). These were ana-

tomical studies, however, and the mere presence of corpora lutea does not indicate that its specific hormone is responsible for all the changes taking place at the moment.

Full mammary development in rabbits was brought about by Parkes (94) by the injection of alkaline extracts of anterior pituitary which he assumed was due to the resulting prolongation of the luteal activity. Turner and Frank (127) also described an increased development over the stage produced by follicular hormone alone when corpus luteum extract was added. Corner, however, reported no proliferation beyond the puberty condition in spayed rabbits following the injection of corpus luteum (progestin) and suggested that Parkes' (94) results were due to a direct effect of the anterior pituitary on the breast. Nelson and Smelser have recently shown that lactation may be induced in the absence of any luteal influence in guinea pigs. Evans and Simpson (35) in injecting anterior pituitary into infantile animals noted mammary development before corpora lutea appeared in the ovaries. The exact rôle of the corpus luteum in mammary growth and lactation remains therefore an undetermined question.

The relationship of the anterior pituitary hormone to growth, as opposed to function of the mammary gland, is difficult to define owing to the problem of determining what part of the glandular enlargement is due to cellular multiplication and what part to swelling of the cells with retained secretion. Corner refers to definite proliferation of the mammary gland in spayed virgin rabbits following 2 weeks administration of extracts of whole sheep's hypophysis. Evans and Simpson (36) obtained hyperplasia of the mammary glands in infantile and adult rats by injection of anterior pituitary, but this was possibly effective by way of the ovary. Other observers working on the stimulus to lactation refer in general terms to the development of the mammary gland under the influence of the anterior pituitary.

The function of lactation has been recognized as something distinct from mere development or growth and due to some separate stimulus. Certain workers have, indeed, observed the appearance of milk after continued injection of follicular hormone alone (Steinach et al; Laqueur et al), but this appears usually to be but slight in amount, perhaps corresponding to the colostrum in the human breast prior to parturition. Turner and Frank (127) suggest that such secretion may arise from the terminal ducts and not be an indication of full alveolar development.

According to Halban's (53) celebrated theory arrived at from a clever analysis of well known clinically observed facts, the breast development in the pregnant woman is due to a substance from the placenta and lactation is really the beginning of involution and due to a cessation of the previous stimulation. Some laboratory confirmation of this view has been given by de Jongh and Laqueur who were able to produce and prolong artificial lactation in adult male and female guinea pigs by giving first large doses of menformon (estrin) and then suddenly reducing the amount. Conversely, it may be shown that the administration of follicular hormone when lactation is once established may reduce milk secretion in mice (Parkes and Bellerby, de Jongh), and rabbits (Smith and Smith). These experiments correspond with the observable diminution in milk supply in lactating women at the onset of a menstrual period or with a new pregnancy.

That the anterior pituitary is an active agent in the stimulation of milk production has been demonstrated by numerous workers. The first of these were Stricker and Grueter, who injected an aqueous extract of bovine anterior pituitary into rabbits under various conditions and obtained milk secretion. Similar results have been reported by Corner, Nelson and Pfiffner, Nelson and Smelser, and Turner and Gardner. There is, however, more or less general agreement that partial development of the mammary gland either through the animal's own ovaries as it matures, by implantation of ovaries, or by injection of follicular hormone is necessary before the anterior pituitary hormone can be effective. That the hypophyseal hormone is necessary to maintain milk secretion, once the latter is established, is shown by experiments on hypophysectomized animals (Allan, H. and Wiles, P., and Collip, Selye, and Thomson).

The probability exists finally that a specific hormone is present in the anterior pituitary which causes milk secretion. Corner found the breast stimulating hormone much less stable than the gonad stimulating hormone. Gardner and Turner suggest its closer relationship with the growth promoting hormone because of its presence in alkaline extracts and propose the term galactin. Riddle and his co-workers have named a specific lactation hormone (prolactin) for which a special test object is used and which is alleged to be effective clinically in the increase of milk in parturient women (Kurzrok et al). The production of lactation in monkeys by means of galactin and prolactin and the absence of histological changes elsewhere in the reproductive tract after the injection of these hormones has recently been reported (Allen, Gardner, and Diddle).

Summary of the hormone effects on the breast. The follicular hormone is the primary agent producing growth of the mammary gland. Its effectiveness may be limited to a development of the duct system only. In large amounts it may alone cause the production of a little milk in some animal species. Its sudden withdrawal apparently results also in some milk secretion either as a direct effect or through a release of pituitary activity. A sudden increase in folliculin during active lactation may reduce the milk supply either by substituting growth for function in the breast or by depressing the pituitary. The corpus luteum has an undetermined influence on the human breast, although in certain species it apparently carries forward the degree of development attained by the stimulus of the follicle hormone for the formation of lobules and acini. The anterior pituitary, possibly by means of a specific lactogenic hormone, appears undoubtedly to further the formation of the active glandular parts of the breast and to produce and maintain the function of lactation.

NERVOUS INFLUENCES AFFECTING THE BREAST

The rapid advance made in the knowledge of the functions of the endocrine glands has left in the background the nervous factors which affect the breast. This is, however, of considerable importance in the present study on account of the nervous aspects of the painful type of chronic mastitis referred to frequently in the literature and discussed by me at some length in a previous paper.

Certain evidence, it is true, exists to indicate a relative independence of the breast from the nervous system. Complete severance from its nerve supply by transplantation does not prevent the breast's reaction to the sex hormones or the secretion of milk (Ribbert, Stricker, Grauer and Robinson). Lactation has been found to be unaffected by removal of almost the entire spinal cord in dogs (Goltz and Ewald) and affected only under certain circumstances by removal of parts of the sympathetic (Cannon and Bright, Bacq, Basch).

More recent experiments and observations suggest, however, at least a slight effect of the sympathetic nervous system on the trophic condition of the breast. Cannon and Bright in spite of earlier negative experiments, noted that, when a long period intervened between sympathectomy and parturition, the milk supply was markedly reduced. The studies of Ernst (34) give more striking implications. He found that in dogs with a resection of the sympathetic chain from the stellate downward to the fifth thoracic ganglion, combined with division of the intercostal nerves which contain autonomic fibers, the affected breast showed signs of retrogression, including disappearance of gland lobules, collapse of alveoli, the growth of connective tissue, and the appearance of histogenic wandering cells. Ernst (34) described also the atrophy of one breast of a girl who had been operated upon for a ganglioneuroma of the thoracic sympathetic of the corresponding side. This patient noted the cyclical premenstrual sensation only in her normal breast, whereas several women having diminished skin sensibility following section of the cutaneous nerves incidental to extensive operations for empyema noted no change in the premenstrual pain. An intrathoracic nerve injury, presumably of the sympathetic, has also been suggested as the cause of the unilateral breast atrophy observed in a large percentage of a series of

cases of predominantly unilateral pulmonary tuberculosis (Kokalj-Kowalewska).

The obvious effect of suckling on the continuation of all normal lactation can scarcely be explained except by a mechanism in which a nervous factor plays an important part. It has not been known, however, whether the discontinuance of nursing caused involution by the pressure of the secretion in the ducts or the absence of nipple stimulation. This question Selye, Collip, and Thomson appear to have decided, for they found that with the nipple tied but suckling continuing, in spite of the complete stasis of secretion, rapid involution did not occur. Furthermore, the nervous stimulus of suckling at the nipples of certain glands maintained active secretion in neighboring glands not being suckled. These workers suggest that the act of suckling reflexly stimulates the hypophysis to secrete prolactin, which presumably stimulates the breast to secrete milk.

The effect of stimulation of the nipple even on the non-puerperal breast is shown in the grotesque instances cited in the literature of lactation in children (Baudelocque), old women (Murat and Patissier, Bartels) and in males. Samuel has reported 5 cases of secretion, including 1 with lumps and 1 with pronounced breast pain, following sexual practices involving nipple irritation. One must accept, therefore, the possibility of parenchymatous mammary changes as a result of local stimulation traveling by nervous pathways. More remote nervous stimuli having a psychic or central nervous system origin appear also to affect the breast. The occurrence of the painful breast in excitable women and the sudden appearance of breast symptoms during periods of emotional tension has been frequently referred to (Lit., Taylor, 123). An hysterical basis for secretion from the nipple has also been claimed (Glorieux). A nerve lesion is clearly suggested in the reported mammary crises of tabes in which there is breast secretion and sometimes pain (Thomas and Kudelski; Preuss and Jacoby; Biberstein; Halban, 53; Siding; Schmidtpott) and in the cases of nipple secretion with syringomyelia (Roussy and Mosinger, Thomas). Lesions of the midbrain have also been cited as the cause of non-puerperal secretion after encephalitis (Riese) and perhaps in association with pituitary tumors (Krestin).

From the observations made by previous writers, as well as from the clinical material to be submitted in this report, the possibility of an effect upon the breast of certain disease processes in the pelvis by way of a nervous pathway becomes important. Sympathetic ganglia in the cervix have been frequently described both in man and the lower animals (Frankenhaeuser; Jastreboff; Blotevogel, 14; Rein; Pissemski). A close relationship between these cells and the hormones of the ovary exists, for it has been shown that the cervical ganglion cells suffer degenerative changes when the animal is castrated or its ovaries radiated and that there is regeneration when such castrated animals are treated by ovarian extracts (Blotevogel, 15, 16, 17; Kennedy).

The effect of stimulation of the pelvic sympathetic has been studied to some extent. Stimulation of the cervix in rodents produces lengthening of the estrus cycle with profound effects on the ovary and mammary glands. In rats this response to mechanical and electrical stimulation can be abolished by lower abdominal sympathectomy (Haterius, 56; Vogt). The suggestion has been made, therefore, that the condition of pseudopregnancy with its incidental mammary hypertrophy, is initiated by the hormone of the pituitary only after it has itself been activated by stimuli traversing the sympathetic chains from an irritated cervix. Evidence of a pelvic nervous factor in the control of lactation itself is found in the experiments of Selye, Collip, and Thomson in which the lactation regularly occurring after cesarean section in late pregnancy was prevented by distention of the uterus with paraffin following removal of the fetuses.

"CHRONIC MASTITIS" AND "CHRONIC PARAMETRITIS"

Histological changes in the cells of the pelvic sympathetic have been described in a condition which the French writers term "pelvic congestion," the Germans "chronic parametritis." Brief reference to these condi-

tions among the pelvic lesions associated with the painful breast was made in a previous paper (Taylor, 123). Subsequent search of the literature on chronic parametritis revealed that W. A. Freund in his classical paper on this subject had written at length on the accompanying nervous symptoms and had emphasized the frequency of nodules and pains in the breast. These quite independent observations of the association of a painful process in the breast and pelvis, made as the result of studies having quite different starting points, appear important. Furthermore, many of the clinical and pathological characteristics of parametritis or pelvic congestion suggest a similarity to certain forms of chronic mastitis.

Chronic parametritis is according to many writers divisible into two phases, a preliminary congestive phase in which intermittent engorgement of the pelvic vessels is present and a later atrophic stage characterized by fibrosis of the fasciæ and aponeuroses of the pelvis and replacement of the muscular fibers of the uterosacral ligaments and the bases of the broad ligaments. In the early stages the uterus may be enlarged, the cervix hyperemic and secreting excessively, the ovaries congested and possibly edematous. Later with the fibrosis taking the place of congestion, the fundus and cervix are smaller and firmer, the ovaries furrowed, shrunken, and sclerotic, and the uterosacral ligaments shortened. The most characteristic physical signs are the tenderness in the supports of the uterus and the rigidity of the uterosacral ligaments. Microscopic examination of the paracervical ganglia of Frankenhaeuser may show a perineuritis, displacement of the nerve cells and fibers with connective tissue, and a shrinkage and loss of polygonal shape of the ganglion cells (Freund, W. A., Freund, H. W., Cotte and Dechaumé).

The symptoms in the congestive stage of the disease consist in diffuse lower abdominal pain, backache and leucorrhea, these complaints all being increased before the menstrual periods. At first menstruation may be normal or increased, but later there is a steadily decreasing flow till the periods last but 2 days or less (Freund, W. A.). Nervous manifestations, particularly in the form of anxiety and sexual disturbances are extremely common.

Chronic parametritis and pelvic congestion have been referred to a multitude of causes and probably several factors are contributory. The following have been mentioned particularly: uterine malpositions (Cotte); sclerocystic ovaries (Siredey); endocervicitis (Graefe) adnexal inflammatory disease; constipation (Schultze, Freund, W. A., Mueller, Opitz, Fraenkel); fatigue and certain occupations (Cotte, Siredey); certain sexual difficulties, including excessive coitus, certain contraceptive measures, and masturbation (Kehrer, Fraenkel, Freund, W. A., Cotte); certain psychosexual disturbances and anxiety states (Kehrer, Fraenkel, Meyer-Ruegg).

POSSIBLE CAUSES OF CHRONIC MASTITIS

1. From a theoretical standpoint a generalized hypertrophy of the breast or a proliferation of certain of its constituents, particularly the ducts and acini, might result from the excessive or prolonged stimulation of the follicle hormone, by a direct or indirect effect of the anterior pituitary or possibly by the corpus luteum. Similarly, abnormal secretion might result from stimulation by the anterior pituitary or from a sudden withdrawal of the follicular hormone. The histology resulting from such stimulation should at first be a fairly regular epithelial proliferation which might give rise subsequently to various atypical effects after repeated intermittent stimulation and incomplete regression.

2. A mechanism similar to that producing chronic parametritis is also a possible factor in the causation of chronic mastitis. For such a theory one must assume a nervous effect upon the breast originating directly in some psychic disturbance or indirectly from an irritated pelvic sympathetic system and resulting primarily in vascular dilatation and hyperemia. Unfavorable mechanical conditions found in the shape and support of the breast would undoubtedly be contributory. A condition of chronic engorgement may lead to secretory disturbances in the breast epithelium, fibrosis, and later perhaps irregular epithelial proliferation. The analogy

which can be drawn between the histology of many cases of chronic mastitis and that described for chronic parametritis as well as the frequency with which the pelvic and breast conditions are found together make it necessary to work with such an hypothesis.

THE HISTOLOGY OF THE BREAST IN RELATION TO THE MENSTRUAL CYCLE

The ovarian theory of origin of chronic mastitis rests in part on the alleged existence of a monthly cycle of epithelial proliferation and regression in the breast. On this subject divergent opinions are held by the various German writers although only one study, that claiming the most extreme degree of epithelial hyperplasia, is frequently cited in America.

Rosenburg, in 1922, studying breast tissue obtained at autopsy and correlated with the menstrual cycle by examination of the ovary and endometrium, concluded that there is a sprouting of the duct epithelium to form acini before each menstrual period and an almost complete disappearance of all epithelial structures except the ducts in the intermenstruum. These findings have been accepted with numerous reservations by a considerable group of writers most of whom, however, examined only a few cases (Polano; Ernst, 33; Sebening; Berberich and Jaffé; Loeschke; Graf; and Luchsinger y Centeno). In America the doctrine of a cycle of epithelial growth in the breast has been taken up with enthusiasm. Ingleby writes that the premenstrual proliferation is much more rapid than carcinomatous growth. Lewis and Geschickter offer a further elaboration in stating that the expansion of the duct system begins at the mid period of the cycle, while the increase in acinar elements is to be noted from the twenty-sixth to the twenty-eighth day.

Dieckmann reviewed Rosenburg's work and noted that his cases representing the intermenstrual disappearance of the glands were for the most part taken from young women, those showing premenstrual proliferation from older ones, in which age and not the cycle might have increased the amount of glandular tissue. Dieckmann himself did not find definite evidence of epithelial proliferation and regression but regarded the premenstrual change as a kind of intralobular edema with a loosening of the fibers of the mantle tissue about the acini, which was followed after menstruation by a sclerosis of this intralobular connective tissue. With this view Kueckens, Dietrich and Frangenheim and Moszkowicz (82) are in substantial agreement and even Ernst (33) and Rosenburg noted certain changes in the connective tissue and in the definition of the lobules as well as their described epithelial modifications. Besides these changes there have been reported a menstrual and postmenstrual lymphoid and plasma cell infiltration of the mantle tissue (Ernst, 33) and hyperemia with secretion in the ducts during menstruation.

On account of these conflicting views, it became necessary to study independently a new series of breast sections in relation to the menstrual cycle. Accordingly 41 cases have been collected in which grossly normal tissue was removed from the breast at the time of the excision of a breast tumor. The position in the cycle was determined from the history of the first day of the previous menstruation and in most cases of the succeeding period as well. The material is concededly inferior to certain previous studies in that the tissue was taken in the neighborhood of a definite disease process, from variable parts of the breast and was stained only by a routine hematoxylin-eosin method. It affords at least a basis for an intelligent evaluation of the existing mass of contradictory data.

In order to determine if possible the histological basis of abnormal premenstrual breast changes, the cases have been divided into those with and those without premenstrual pain or swelling. For each case a tabulation was made of the average number of acini per lobule, the number of lobules per low power field, the presence of intracellular or extracellular secretion, the definition of the lobule, the character of the intralobular connective tissue and the degree of lymphoid infiltration. The material used is shown in Table I.

The chief feature of this series was the immediately evident variability of the lobular development in different breasts, irrespective of the time of the cycle. This is in direct accord with Dieckmann who recognized a

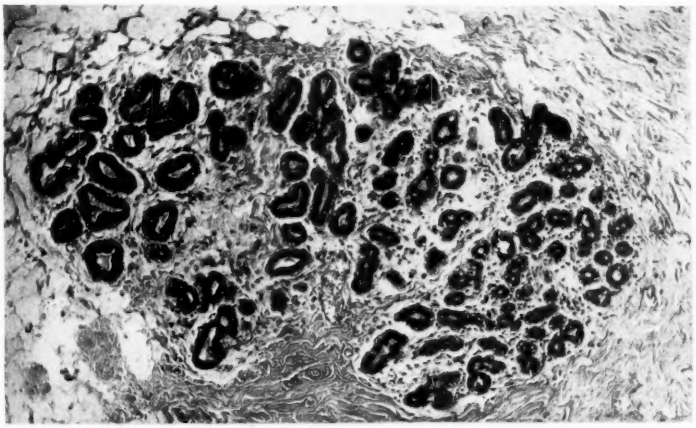

Fig. 1. D5966. Well developed lobule with periacinar "edema" 3 days before the menstrual period. Patient 40 years old, with 3 children, menstruating every 28 days for 5 days with slight 3 day premenstrual breast pain.

mature and an immature type of lobule somewhat dependent on the patient's age. This variability makes difficult attempts to prove the occurrence of premenstrual proliferation of the ducts by comparing single sections from different individuals, but makes it readily possible to arrange sections to illustrate any special morphological process that one may expect to find. Taking Figures 1 and 2, one has the evidence to demonstrate the Rosenburg theory, but the reverse can be as readily shown, using Figures 3 and 4.

A. Epithelial changes. The total disappearance of acini claimed by Rosenburg to take place in the interval must be a rare occurrence for in only 2 of the cases of the present series were acini largely absent. Furthermore the average number of acini per lobule as determined by actual count of the cross sections of the acini of numerous gland fields did not show any consistent differences in women operated upon at different times in the cycle. In particular it was interesting to note the persistence of acini and well developed lobules in the prolonged intermenstruum of women with cycles of 6 or 7 weeks (Fig. 5), in the early menopause (Fig. 6) and even several months after large doses of high voltage X-ray had been given to the ovaries (Fig. 7). Finally in 1 case sections obtained by deliberate biopsy from identical parts of the two breasts on the fourteenth day of the cycle and again on the day of onset of menstruation showed

TABLE I.—DISTRIBUTION AND SCOURCE OF NORMAL BREAST SECTIONS

		Menstruation	Interval	Premenstruation
Cases without pain	Fibro-adenoma	2	5	2
	Chronic mastitis	1	4	0
	Carcinoma	3	0	1
Cases with pain	Fibro-adenoma	4	1	5
	Chronic mastitis	3	8	0
	Carcinoma	0	0	2
Total		13	18	10

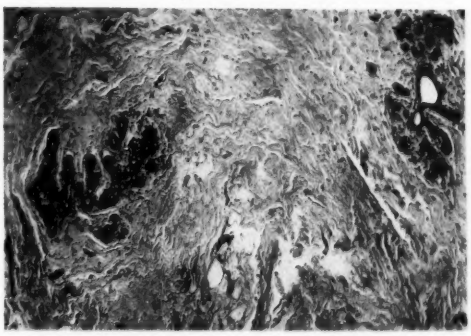

Fig. 2. E3640. Fibrosis of the lobule and apparent shrinkage of the acini on the fourteenth day of the cycle. Patient 20 years old, single, menstruating every 28 days for 5 days without premenstrual breast symptoms.

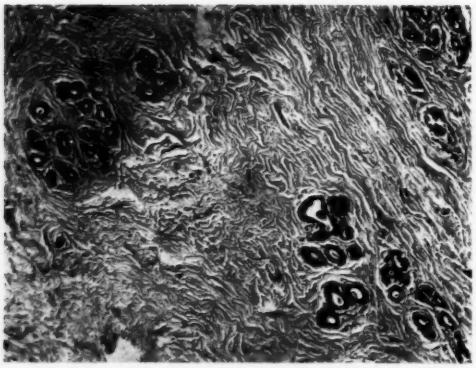

Fig. 3. D3891. Slight acinar development and undifferentiated intralobular connective tissue 3 days before menstruation. Patient 23 years old, single, menstruating every 28 days for 4 days without premenstrual breast symptoms.

no definite differences in the degree of acinar development (Figs. 13 and 14).

Cyclical intracellular changes in the epithelium are probable, for near the time of menstruation the individual cell outlines may be more distinct and the acini often appear larger and somewhat dilated, whereas in the intermenstruum they are usually collapsed and inconspicuous. There is, however, little mitosis to prove the actual formation of new epithelium, nor when menstruation is over is there any massive desquamation of epithelial cells into the ducts. The degree and regularity of an epithelial cycle of proliferation and regression in the breast appears, therefore, to have been exaggerated, and its very existence to require better proof than has yet been submitted.

B. Connective tissue changes. The premenstrual changes in the intralobular connective tissue received general confirmation in this series. Sections taken shortly before menstruation usually showed the connective tissue of delicate texture with its fibers widely separated, giving the lobule a sharp outline against the dense general supporting tissue of the breast (Fig. 1). In the intermenstruum the mantle tissue was coarse and dense and the outline of the lobule relatively indistinct (Fig. 2). Nevertheless exceptions occurred, both in the form of persistent lobular definition in the interval and nearly complete absence of connective tissue differentiation

Fig. 4. E6700. Persistence of lobules with numerous acini on the thirteenth day of the cycle. Patient 28 years old, married without pregnancies, menstruating every 28 days for 5 days with premenstrual tenderness and swelling of the breasts.

Fig. 5. D2933. Persistence of acini in the interval of a prolonged cycle, 18 days after the previous menstruation and 35 days before the succeeding period. Patient 21 years old, married, without pregnancies, menstruating every 5 to 8 weeks for 7 days without breast symptoms.

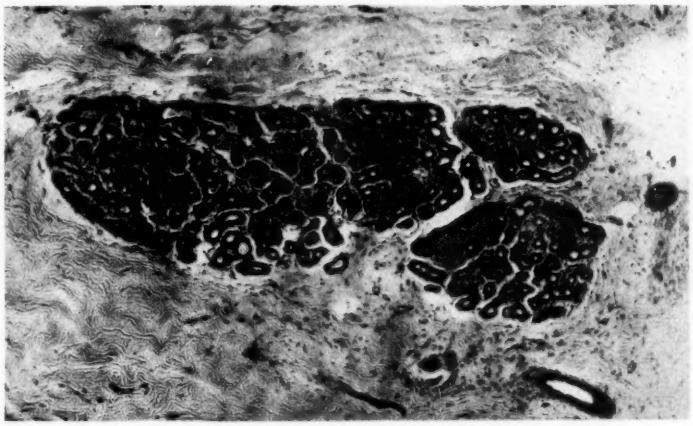

Fig. 6. D3714. Persistence of acini in the early menopause, 6 months after the last menstrual period. Patient age 47, married, childless, operated upon for localized chronic mastitis.

shortly before menstruation. The presence or absence of a round cell infiltration was in this series chiefly dependent upon the disease process for which the operation was undertaken.

HISTOLOGICAL BASIS OF THE PAINFUL BREAST

Depending on the clinical appearance of the painful breast many of the older writers assumed that the changes had a vascular basis and were the result of venous congestion. With the advent of belief in a premenstrual proliferation, the pain has been ascribed to an epithelial increase in the breast. Rosenburg wrote: "The sprouting by the rapidity of the growth causes the clinically noted tenseness in the breasts." Cheatle and Cutler, with the assumption that the painful breast is based on the pathological process which they term mazoplasia, ascribe the pain to a distention of the ducts with desquamated epithelial cells.

Pain may occur in breasts which are essentially normal to palpation although in the more severe cases the breast is diffusely nodular. In certain cases, furthermore, the pain may be localized in a single nodule. This offers three types, the histology of which must be considered.

A. The painful breast normal to clinical examination. The breasts of a considerable

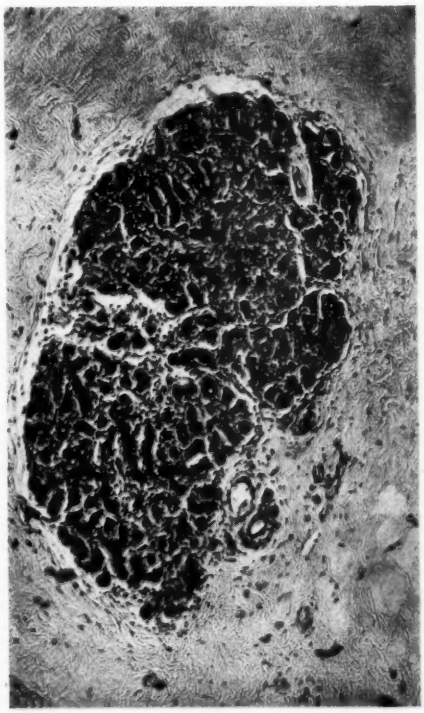

Fig. 7. C4402. Definite lobules with persistence of acini 15 months after hysterectomy and 12 months after a castration dose of X-ray to the retained ovary. The patient, a single woman of 43, with pain, nodules, and enlargement following operation for myoma uteri.

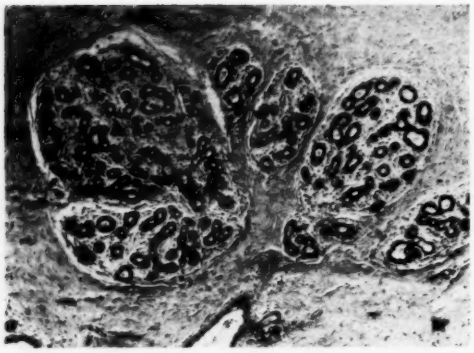

Fig. 8. E5991. "Edema" of lobule in a case of painful breast 2 days after the onset of menstruation. Patient 36 years old, with a history of five miscarriages, menstruating every 21 days for 4 days with 7 days of premenstrual breast pain and heaviness.

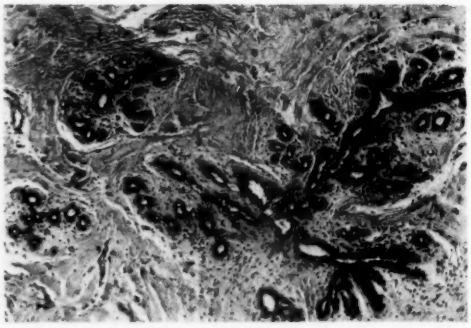

Fig. 9. E5502. Normal breast tissue with premenstrual lobular edema, excised as a circumscribed lump 4 days before a menstrual period. The patient an unmarried woman of 27, menstruating every 28 days for 6 days with an 8 day premenstrual and menstrual painful swelling of the breasts.

percentage of all women are before the menstrual periods slightly swollen, slightly sensitive, with possibly a little evidence of hyperemia in the form of darkening of the areola and dilatation of the superficial veins.

For the study of this condition, we have had to accept tissue removed at the time of an operation for fibro-adenoma from breasts grossly normal except for the circumscribed tumor and have for comparison 9 specimens from women without any premenstrual breast symptoms and 10 with premenstrual pain, swelling, or both. The cases with symptoms showed a slightly more developed lobule as indicated by a count of the acini and in some cases a very pronounced "edema" of the mantle tissue (Fig. 8).

This material, admittedly too small for final conclusions, suggests that the common premenstrual breast symptoms occur in women with breasts at least fairly well developed who react somewhat more than the average to stimuli producing vascular dilatation and probably fluid changes in the intestitial tissue of the lobules.

B. The painful breast with diffuse areas of induration. The patient who usually applies for treatment for the painful breast exhibits either a diffuse nodularity or particularly a nodularity of the upper outer quadrant. This differs from a true tumor for its margins cannot be felt with the breast pressed flat against the chest, but when the breast is raised and examined between the fingers a roughly circumscribed area often involving the whole upper outer quadrant can be readily outlined. The nodularity is more marked before the menstrual periods and may be almost undetectible in the interval. The patient complains of pain beginning from a few days to 2 weeks before the menstrual period and often extending to the axilla, shoulder, arm, and over the lateral thoracic wall.

Pathological sections of such tissue reveal a somewhat varied morphology, so that one may conclude that many abnormal processes in the breast give pain under the influence of the hyperemia of the premenstrual phase. It is barely possible, however, that the different morphological appearances represent successive stages or local variations of a single basic process.

In one group of cases the histology shows little to distinguish the section from the normal. Here one must conclude that the palpable abnormality represents a localized hypertrophy of all the tissues of the breast maintaining their normal relationships to each other or else that a vascular change such as a general slight edema has brought into sharp relief one part of the breast (Fig. 9). A pathological report of chronic mastitis in such tissue is usually made on the basis of the clinical diagnosis.

Fig. 10. D3841. Fibrosis and distortion of lobule, twelfth day of cycle. Patient age 45, married with 2 children, menstruating every 28 days for 4 days, with premenstrual breast pain.

In a second group of cases, there is a striking increase in the density of the connective tissue. This may be apparent even in the gross in the texture of the breast tissue which is white, glistening, and fibrous with a disappearance of most of the adipose tissue between the lobules. Under the microscope there is often a distortion of the normally well circumscribed lobules due to a fibrosis of the mantle tissue either by its local transformation or by an ingrowth of the coarse supporting tissue of the breast (Fig. 10). In this group, there is little evidence of epithelial proliferation, and in many cases there may be an actual diminution in the size of the lobules and the number of acini.

In a less frequent form there are signs of proliferation of the acini, so that the lobules are found close together, often coalescing, and the acini spread diffusely through the supporting tissue of the breast (Fig. 11). Not infrequently this and the preceding type are combined and there is evidence of both glandular and connective tissue growth. Finally the tissue removed from certain cases with pain may exceptionally exhibit the miscellaneous structures found in the more fully developed cases of Schimmelbusch disease, such as cysts, adenomas of the sweat gland type, intraductal papillomas, and extensive round cell infiltration.

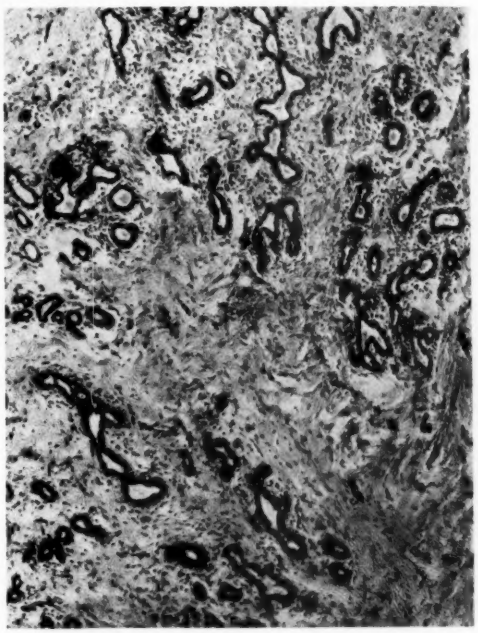

Fig. 11. E3928. Loss of lobular arrangement with diffusion of acini, fifth postmenstrual day. Patient a woman of 38, married with 6 children, menstruating every 28 days for 2 days with premenstrual swelling of the breasts.

C. The histology of the circumscribed painful nodule. The premenstrual breast pain may be localized in certain sharply circumscribed areas of the breast and over a period of months a lump may regularly appear during the week before menstruation and to a large extent disappear thereafter. Such "disappearing lumps" may be found histologically to differ little from the normal breast tissue (Fig. 9), or they may show an increase in connective or epithelial elements with a loss of the lobular outline. On the other hand, typical fibroadenomas may also undergo the same premenstrual enlargement and increase of tenderness.

HISTOLOGY OF THE HYPERTROPHIED BREAST

The hypertrophies of this series were for the most part minor degrees of permanent increase in size reported by the patient herself and not reaching obviously abnormal proportions. Frequently the enlargement was

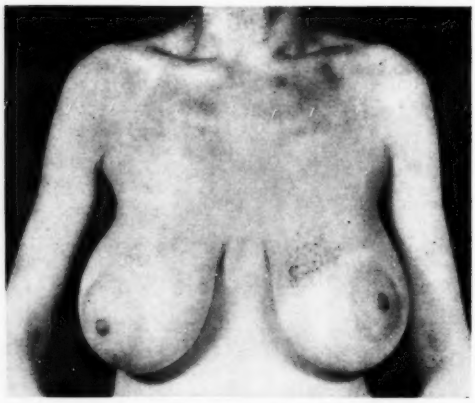

Fig. 12. Premenstruai hemorrhages in the skin of the breast in a case of painful hypertrophy 3 days before menstruation. Patient a divorced woman of 25 with a history of one miscarriage, menstruating every 2 to 6 weeks, for 3 to 5 days with scant flow, with severe dysmenorrhea and pronounced breast pain and swelling.

unilateral and usually more marked in the outer quadrants, sometimes giving the breast a distorted shape with the nipple displaced toward the midline. Palpation showed as a rule distinct nodularity or circumscribed areas of induration in the tails. Pain and tenderness were always present, sometimes so severe as to require sedatives to permit sleep.

Premenstrual increase in the size and weight of the breasts again suggested congestion and hyperemia. The importance of the vascular factor was, however, brought out most strikingly by one case in which areas of minute hemorrhages appeared in the skin of the breasts before each menstrual period (Fig. 12).

This type of hypertrophy appears therefore to be closely related to the painful nodular breast, and is clinically quite different from the painless hypertrophies seen in children (Frank, Bettinger, Pahl, Fasold, Siegmund, Novak) in the presence of ovarian tumors.

The histological characteristics of these painful hypertrophies could be studied in only a few cases. In certain examples at least there is a marked increase in fibrous tissue, giving a dense, glistening white appearance to the gross specimen, a fact noted also in a case described by Leriche (71). Under the microscope there may be large areas of connective tissue nearly free of glands and the few lobules are small with the acini separated by coarse fibrous tissue (Figs. 13, 14). Much less commonly, signs of epithelial proliferation and cysts may be present. The general picture corresponds closely with the description given for the histology of the painful breast.

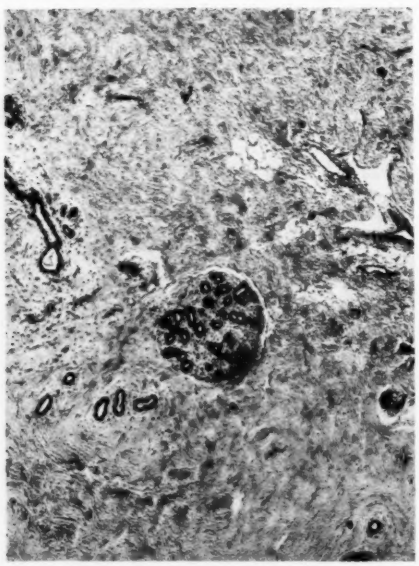

Fig. 13. 13410A. Fibrosis and absence of epithelial hyperplasia in painful hypertrophy of the breast, section on the fourteenth day of cycle. Patient the same as in Figure 12.

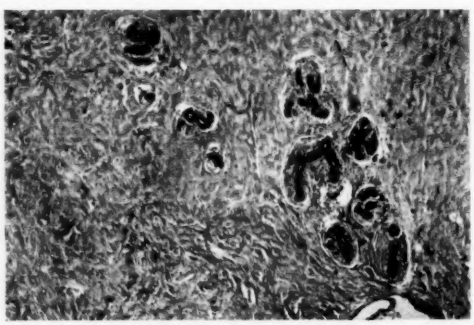

Fig. 14. 13410B. Fibrosis and absence of epithelial hyperplasia in painful hypertrophy, section 2 hours after the onset of menstruation. Patient the same as in Figures 12 and 13.

HISTOLOGICAL BASIS OF THE NON-PUERPERAL SECRETING BREAST

Clinically there are several types of breast from which secretion can be expressed but they apparently fall into two principle groups.

1. *Non-puerperal lactation.* In this type the breasts are soft, usually non-painful, but with hyperemic areolæ and erect nipples. The secretion is usually thin and has the cloudy appearance of colostrum but in marked cases it spurts from the ducts in the form of white opaque droplets of true milk. The secretion of this type is nearly always bilateral. There is no indication for operation and, although a number of such cases have been observed clinically at the Memorial Hospital, no histological material has been obtained.

2. *Type associated with disease of the ducts.* In the second type the secretion is less in amount and of varied character. It may be serous, watery, oily, purulent, or somewhat inspissated so that it can be squeezed from the breast in worm-like coils. The patient usually complains of pain which is less severe and more continuous than in the typical painful nodular breast. The consistence of the breast with secretion may be fairly soft, or diffusely nodular, sometimes with the dense outer quadrant induration of the simple painful breast. Occasionally dilated ducts are palpable beneath and around the areola. Regular cyclical variations in the amount of secretion were not noted in this series.

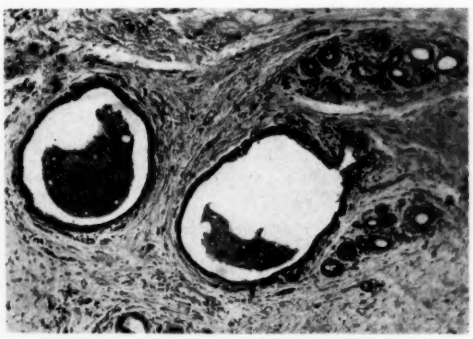

Fig. 15. D5169. Dilatation of ducts with retained secretion in a case with secretion from the nipple, section on the twelfth day of the cycle. Patient 39 years old, menstruating every 35 days for 4 days with premenstrual pain and swelling of the breasts.

On gross section of such breasts, the ducts are found dilated and oozing with secretion, usually of the thick, semi-solid type. Histological examination shows the ducts widened to cystic proportions and filled with granular, amorphous material. The lining cells are usually flattened and overlie a zone of connective tissue infiltrated with lymphocytes (Fig. 14). Increase and diffusion of the acini with frequent dilatation of the smaller ducts is common toward the periphery of the breasts. Finally with secretion from the nipple one may encounter marked proliferative activity of the duct epithelium, occasionally filling the lumina with solid masses of cells or developing papillomata (Fig. 15).

TERMINOLOGY

The name of "chronic mastitis" on account of its familiarity has been retained in this paper as a general designation for the diffuse breast diseases associated with pain or discharge. The term is not a good one, but appears as useful as such recently proposed names as "mazoplasia" or "cyclomastop-

Fig. 16. D2803. Polypoid adenomas of the sweat gland type from a case with a serous discharge from the left nipple. Patient a married woman of 24 with one child, menstruating every 22 days for 6 days with severe cramps and intermittent pain and swelling of the breasts.

athy." The history of uterine nomenclature has shown a similar evolution from terms with suffixes indicating inflammation, such as "chronic endometritis" and "adenomyositis," through the noncommittal "metropathia," to the more anatomical terms, "hyperplasia" and "adenomyosis." A general word which accurately describes the basic changes in the common types of diffuse breast disease and which is in harmony with nomenclature used elsewhere in the reproductive tract is "adenofibrosis." The term is similar to the word, "fibro-adenomatosis," adopted by Semb after his extensive histological studies.

SUMMARY ON HISTOLOGICAL CONSIDERATIONS

The difference of opinion expressed by various observers and the easily found exceptions to the Rosenburg conception indicate that the cycle of a general premenstrual epithelial proliferation and postmenstrual regression has probably been exaggerated.

A premenstrual hyperemia of the breast is, however, obvious from the gross changes in the size and the weight of the breast and the deepening of the color of the areola. Microscopic evidence of this vascular change is found in the greater definition of the lobule and in the alteration of the character of the intralobular connective tissue.

The painful breast in its simplest form exhibits an increase in these premenstrual vascular changes. To refer the abnormal premenstrual swelling of the breast to excessive epithelial proliferation or the pain to the distention of the ducts with desquamated cells is contrary to many histological observations.

The tissue in the milder forms of the painful breast may therefore appear almost normal under the microscope or may show excessive "edema" of the intralobular connective tissue. In the cases with pain and marked nodularity there may be evidence also of irregular fibrous tissue and epithelial proliferation.

The histology of the painful hypertrophies of this series was in general similar to that of the painful, nodular breast.

The histology of the breast with discharge from the nipple is variable and includes duct dilatation, stasis, and catarrhal inflammation, frequently with secretion and hyperplasia of the epithelium and fibrosis and round cell infiltration of the connective tissue.

NOTE.—The second part of this study to be printed in the following issue of this journal will contain the results of a clinical and laboratory investigation of 261 women with these types of breast disease. The data to be presented will include the record of menstrual types and anatomical conditions found in the pelvic organs, notes on the gross appearance of the ovaries and the histology of the endometrium in certain of these cases in which pelvic operations were performed, and the result of biological tests for certain ovarian and pituitary hormones in the blood and urine of a further group of patients.

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THE INFLUENCE OF PEPSIN AND HYDROCHLORIC ACID ON THE HEALING OF GASTRIC DEFECTS

ARTIFICIAL GASTRIC ULCER

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PREVIOUS experimental attempts to prevent healing of the stomach after injury by the administration of hydrochloric acid have met with indifferent success. The literature on this subject was recently reviewed in our publication on the relationship of the subcutaneous injection of histamine to the healing of mucosal defects (4). To our knowledge, however, the effect of the administration of pepsin has not been studied. In these experiments, therefore, we have administered excessive amounts of pepsin and hydrochloric acid to animals with mucosal defects in the stomach and have observed the rate and character of healing. The results will be compared with the healing of similar defects in a group of animals receiving equal amounts of hydrochloric acid without pepsin and with controls receiving neither acid nor pepsin.

METHOD

Adult cats were used, ranging in weight from 2.8 to 4.5 kilograms. Under ether anesthesia and through a gastrostomy wound a 1 square centimeter defect was cut in the mucosa of the posterior wall of the antrum, 1 to 3 centimeters from the pylorus, and the underlying muscle was scarified. Beginning on the day after operation 1 to 3 doses of hydrochloric acid and pepsin, or of hydrochloric acid alone, were administered daily by stomach tube. The doses given, 65 to 75 cubic centimeters, were put in the stomach at hourly intervals for it had been determined that this amount would remain in there for about 60 minutes. Thus the maximum exposure of the defect to the administered acid or acid plus pepsin was attained. The animals were allowed to eat a mixed laboratory diet. The food was removed early enough before the solutions were given to allow the stomach to empty and returned to the cage after sufficient time had elapsed for them to leave the stomach. With this scheme of feeding, food did not interfere with the action of the pepsin or of the acid. When the cats were killed at the various intervals, their stomachs were distended with formalin and studied grossly and microscopically for disturbances of healing.

The concentration of hydrochloric acid given to the majority of the cats ranged between hydrogen-ion concentration 1.0 and 1.4. This range of acidity is about equivalent to that for the gastric secretion obtained from the cat by stomach tube after histamine stimulation. Chart I represents the average secretion in four cats resulting from the injection of two milligrams of histamine per kilogram. The hydrogen-ion concentrations of these secretions determined colorimetrically varied between 1.0 and 2.0. Concentrations of acid above and below this range were also given to a few animals. In the absence of data on the physiological variations in pepsin content of the gastric secretion of the cat, a wide range of

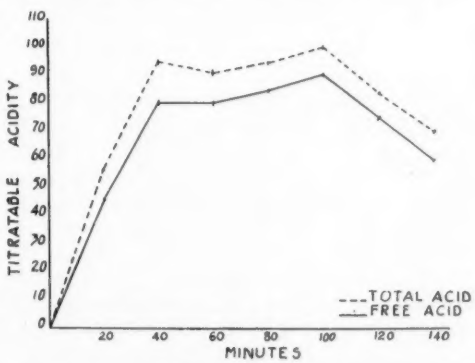

Chart 1. Average acidity of gastric secretion in four cats after 2 milligrams of histamine per kilogram. Average individual volume of secretion was 60 cubic centimeters. Hydrogen-ion concentration varied from 1.0 to 1.6. Interrupted line, total acid; straight line, free acid.

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TABLE I.—HEALING OF PREPYLORIC DEFECTS WITH ACID ALONE

Cat No.	Acid pH	Amount c.cm.	Estimated minimal length of time in stomach per day (hours)	Days	Number of aspirations after 1 hr.	pH of reaspirated juice	Results
1	1.2	65 b.d.	2	7	Not done		Normal healing
2	2.0	65 b.d.	1	7	Not done		Normal healing
3	1.1	65 b.d.	2	7	Not done		Normal healing
4	1.4	65 b.d.	2	7	2x no return		Normal healing
5	1.2	65 b.d.	2	7	6, returned	2.0, 1.4, 1.5, 1.8	Moderate surface necrosis
6	1.2	75 b.d.	2	13	7, returned	1.2, 1.4, 1.5, 1.4, 1.6, 1.6, 1.2	Healed
7	1.1	75 b.d.	2	7	1, returned	1.2	Normal healing
8	1.1	75 t.i.d.	3	14	Not done		Healed
9	1.1	75 t.i.d.	3	7	Not done		Normal healing
10	1.1	75 t.i.d.	3	10	Not done		Normal healing
11	0.9	75 b.d.	2½	13	1 hr., 1¼ hrs.	100–108 m.eq. free acid present	Open lesion—Healing delayed
12	0.9	75 b.d.	2½	13	1¼ hrs.	126–132 m.eq.	Open lesion—Healing delayed
13	0.9	75 b.d.	2½	14	1 hr., 1¼ hrs.	Free acid present 112–125 m.eq.	Open lesion—Healing delayed

concentrations varying between 0.05 to 2 per cent of pepsin 1:10,000 (Armour's) was used.

RESULTS

The healing of mucosal defects in the stomach of the cats receiving neither acid nor pepsin was as follows: At 1 week, epithelization had begun and at 2 weeks the lesion was completely closed. Because of the difficulty, however, of destroying the same amount of tissue at each operation, 5 more defects were cut deeper in order to evaluate the effect of a greater destruction of tissue on the healing process. These lesions were likewise studied after 1 week of healing and although some still had a small amount of surface exudate present, in most instances epithelium was beginning to form, and the fibrous tissue had already regenerated (Fig. 1). In comparing the lesions exposed to acid and pepsin, therefore, interference with healing was not considered noteworthy unless the surface exudate was more marked than in these controls. With this precaution, misinterpretation caused by inevitable variations in the size of the original defect was avoided.

THE EFFECT OF HYDROCHLORIC ACID ALONE ON THE HEALING OF THE DEFECT

Either two or three times per day 13 animals received between 65 and 75 cubic centimeters of hydrochloric acid per dose. The details of the amounts given and the hydrogen-ion concentrations are shown in Table I. These cats ate well, and their weights were maintained. Seven of these receiving acids with hydrogen-ion concentrations varying from 1.1 to 2 were killed after 1 week. The lesions in their stomachs had undergone less contraction than had controls, and although histologically there was a small amount of surface exudate still present, yet only in one animal (No. 5) was the delay of healing more marked than had occurred in the controls (Figs. 2 and 3). Three other animals receiving acid alone of hydrogen-ion concentration 1.1 to 1.2 were killed after longer periods of time, on the thirteenth and fourteenth days of healing. At 10 days epithelization was progressing normally, and at 13 and 14 days the defects were covered with regenerated epithelium. On the other hand, all the lesions in 3 animals receiving acid of a hydrogen-ion concentration of 0.9, killed after 13 or 14 days of healing, showed a frank delay of the process. Grossly, these lesions were open to about half the original size and indurated, but microscopically healing, although retarded, was definitely taking place.

To summarize then, the administration of hydrochloric acid of hydrogen-ion concentration 1.1 or greater had little or no effect upon the healing of the mucosal defect whereas

TABLE II.—ACID PLUS PEPSIN

Cat No.	Conc. of pepsin (%)	pH	Amount (c.cm.)	Average exposure per day	Days	Number of aspirations after 1 hr.	pH of reaspirated juice	Results
14	0.05	1.2	65 b.d.	2 hrs.	7	3, no return		Slight surface exudate
15	0.1	1.4	50 b.d.	2 hrs.	7	Not done		No surface exudate
16	0.1	1.4	50 b.d.	2 hrs.	7	Not done		Slight surface exudate
17	0.1	1.4	70 b.d.	2 hrs.	7	Not done		No surface exudate
18	0.1	1.4	75 b.d.	2 hrs.	7	Not done		Slight exudate
19	0.2	1.2	65 b.d.	2 hrs.	7	2, return		Slight exudate
20	0.2	1.2	65 b.d.	2 hrs.	7	7, return	1.4, 1.6, 2.2, 1.4	Moderate exudate
21	0.4	1.2	65 b.d.	2 hrs.	7	Not done		Moderate exudate
22	0.4	1.2	75 b.d.	2 hrs.	7	Not done		Moderate exudate
23	0.4	1.1	75 t.i.d.	3 hrs.	7	3, return		Perforation
24	0.4	1.2	75 t.i.d.	3 hrs.	7	Not done		Extensive surface exudate
25	0.4	1.1	75 t.i.d.	3 hrs.	9	2, return		Moderate exudate
26	0.4	1.1	75 t.i.d.	3 hrs.	10	5, return		Perforation
27	0.4	1.1	75 t.i.d.	3 hrs.	10	Not done		Marked surface exudate
28	0.3	1.2	75 t.i.d.	3 hrs.	13	Not done		Very little healing
29	0.4	1.4	75 b.d.	2 hrs.	13	5, return	1.4, 1.6, 1.6, 1.7, 1.4	Almost covered with epithelium
30	0.4	1.2	75 t.i.d.	3 hrs.	13	Not done		Almost covered with epithelium
31	1	1.1	65 t.i.d.	3 hrs.	13	1, return		Almost covered with epithelium
32	0.2	1.1	65 t.i.d.	3 hrs.	14	3, return	1.4	Covered with epithelium
33	0.4	1.2	75 t.i.d.	3 hrs.	14	1, return		Almost covered with epithelium
34	0.2	1.0	75 t.i.d.	3 hrs.	14	7, return	1.6, 1.6, 1.2, 1.8, 1.5, 1.4	Almost covered with epithelium
35	0.4	2.0	65 b.d.	1 hrs.	7	Not done		Slight surface exudate
36	0.1	2.8	65 b.d.	1 hr.	7	Not done		No surface exudate
37	0.4	0.9	75 b.d.		14	1¼ hrs. 1½ hrs.	Free acid present Free acid present	No surface exudate
38	0.4	0.9	75 b.d.		14			Open lesions
39	0.4	0.9	75 b.d.		14	1¼ hrs. 1¼ hrs.	94–106 m.eq. 94–114 m.eq.	Open lesions Open lesions

acid of a hydrogen-ion concentration 0.9 did delay healing.

THE EFFECT OF PEPSIN AND HYDROCHLORIC ACID ON THE HEALING OF THE DEFECT

Twenty-six animals received artificial gastric juice containing hydrochloric acid and commercial pepsin (1:10,000 Armour) (Table II). The doses given varied between 50 and 75 cubic centimeters, and the pepsin content ranged between 0.05 and 1.0 per cent. The hydrogen-ion concentration of the mixtures extended from 0.9 to 2.8. Two or three doses were administered daily. The animals which received two doses daily ate fairly well and remained in good condition while those receiving three doses occasionally vomited and had a coincidental loss of appetite and weight. Twelve of these cats were killed after 1 week of healing, and four of the defects showed considerable interference with healing, i.e., slough in the floor of the defect grossly and microscopically an abundant polymorphonuclear exudate on the surface and absence of growth of epithelium at the edges (Figs. 4 and 5). One animal died of a perforated ulcer on the seventh day (Fig. 6). Five other lesions in this group likewise showed some surface exudate, but inasmuch as the amount did not exceed that seen in the controls, no significance was attached to it. The lesions in the 2 remaining animals showed normal healing, but

TABLE III.—CATS RECEIVING EPHEDRINE AND ARTIFICIAL GASTRIC JUICE

Cat No.	Gastric juice	Amount of ephedrine per kilogram	Calculated hrs. of peptic activity per day	Reaspirations several hours after inhalation	Days	Results
40	Pepsin .4% pH 1.1 75 c.cm. o.d.	3 mgm.	2½	2 hrs.—free acid 3 hrs.—none	7	Marked surface necrosis
41	Pepsin .4% pH 1. 75 c.cm. o.d.	3 mgm.—7 days none 7–14 days	2½	2 hrs.—pH 3 3 hrs.—none	14	Healed
42	Pepsin 2% pH 1.2 65 c.cm. b.d.	5 mgm.	4	2 hrs.—pH 1.8	14	Healed
43	Histamine subcutaneously 2 mg./kg.	5 mgm.		3 hrs.—free acid 3 hrs.—none 3 hrs.—free acid	14	Open-healing
44	Pepsin .4% pH 1.1 75 c.cm. b.d.	5 mgm.	6+	3½ hrs.—free acid 4 hrs.—none 5½ hrs.—free acid	13	Open-healing
45	Pepsin .4% pH 1.1 75 c.cm. b.d.	5 mgm.	8+	3½ hrs.—pH 1.6 3½ hrs.—pH 1.8 4½ hrs.—free acid 5½ hrs.—free acid	13	Open-healing

these cats received in one instance a weak concentration of pepsin and in the other the acidity was weak (No. 36).

Healing was allowed to continue for a longer period of time in the 13 other animals. One was killed on the ninth and another on the tenth day, and each showed marked interference with healing. A third animal died of a perforated lesion on the tenth day. The 10 other animals were killed on the thirteenth or fourteenth days and the defects in their stomachs had started to heal. Histologically there was a thin single layer of regenerating epithelial cells growing in from the margins, and it was evident that the lesions would be completely covered in a few more days. None had the marginal gastritis seen around the chronic gastric ulcer in the stomach of man.

In general, then, the defects in the animals receiving pepsin and acid showed greater delay of healing than did those in the animals receiving acid alone. The effect was most marked when the acidity approached tenth normal (pH 1.0) and with pepsin of 0.4 per cent. On the other hand, the same concentration of hydrochloric acid alone had had little or no effect upon healing. The presence of pepsin in sufficient concentration, therefore, enhances the destructive action of gastric juice and causes a longer delay of healing.

DURATION OF EXPOSURE OF INJURED STOMACHS TO ACID PLUS PEPSIN

Numerous preliminary observations were made on the rate of emptying and of neutralization of the various volumes and concentrations of acid introduced into the cat's stomach. The findings confirmed in principle the reports of other observers (2) on the fate of acid after introduction into the stomach. In general, the acidity was progressively reduced and the time when the fluid finally left the stomach depended on the hydrogen-ion concentration of the solution. Weaker concentrations of acid left the stomach more rapidly than those of greater acidity. Thus with 75 cubic centimeters of hydrochloric acid of hydrogen-ion concentration of 1.2, a small amount could be recovered at the end of 1 hour, and the acidity had decreased to a hydrogen-ion concentration between 1.4 and 2.0 while with the same volume of acid of hydrogen-ion concentration 2.0 introduced, none could be recovered at the end of one-half hour. The addition of pepsin to the acid did not alter these changes.

In order to determine the change in peptic activity of the pepsin hydrochloric acid mixture after being in the stomach for a period of time, two cats were lightly anesthetized with nembutal and given 75 cubic centimeters of a 0.1 per cent solution of pepsin at a hydrogen-ion concentration of 1.1. The stomach content was then aspirated after 1 hour, and the digestive activity determined by the method of Anson and Mirsky. This test demonstrated that very little change in peptic activity had occurred. Moreover, by aspirating the stomach of the animals with defects, we were able to show that injury had no effect on the length of time which the various solutions remained

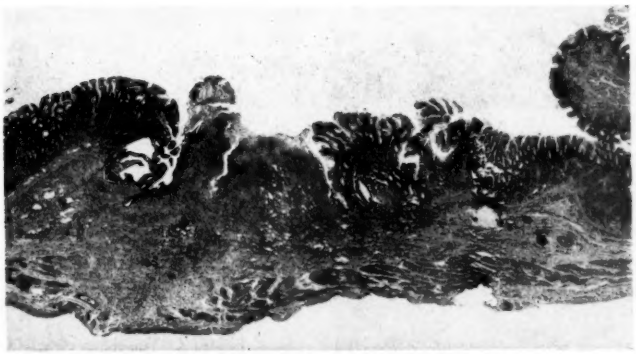

Fig. 1. Character of healing of prepyloric defect after 1 week in stomach of a control cat. The muscularis has been deeply scarified. There is a small amount of surface exudate.

in it or that the changes which occurred in the acidity differed in any way. The details of these findings are recorded in Tables I and II. In the series which received acid alone, it will be noted that the exposure of the defect to acid ranging between hydrogen-ion concentration 1.1 and 2.0 was over 3 hours per day (animals No. 8, 9, and 10). A similar period of exposure was also attained in those animals which received pepsin hydrochloric acid of the same acidity (Animals Nos. 23, 24, etc.).

THE EFFECTS OF LONGER EXPOSURE OF GASTRIC JUICE ON THE HEALING OF THE MUCOSAL DEFECTS

To retain the acid pepsin mixture in the stomach for longer periods of time, coincident injections of ephedrine sulphate were given. This drug decreases peristalsis. With 3 to 4 milligrams per kilogram administered subcutaneously, the solutions remained in the stomach two to four times longer than without it. Five animals (Table III) received solutions of pepsin hydrochloric acid and also simultaneous injections of ephedrine sulphate. The solutions given were of hydrogen-ion concentration 1.0 to 1.2 with pepsin of 0.4 to 2.0 per cent. Two animals received one dose of the artificial gastric juice and ephedrine per day, and 3 received two doses of each. The stomach of one of the former animals was examined at the end of 1 week, and the lesion showed marked interference with healing comparable to that seen with 3 hours' exposure to the acid and pepsin mixture obtained without ephedrine. The 4 remaining animals were killed after 2 weeks, and 2 had open but healing defects while the others were already covered with epithelium. Another animal included in this series received 2 milligrams of histamine—a dose which we have previously shown is effective in delaying healing—and 5 milligrams of ephedrine per kilogram for 2 weeks. When the animal was killed, however, the lesion, although open, was likewise healing.

Aspiration of the stomachs of these cats receiving ephedrine indicated that a single dose of acid and pepsin remained in the stomach for as long as 3½ to 4 hours and that the rate of change of hydrogen-ion concentration was also slower than in the cats not receiving ephedrine. With 75 cubic centimeters of hydrogen-ion concentration 1.1, fluid could still be aspirated at 3½ hours, and it still had a hydrogen-ion concentration of 1.6 (No. 45) (Table III). Thus with two doses of the artificial gastric juice and ephedrine, the lesion was in contact with the acid and pepsin for 6 to 8 hours, but in spite of the prolonged daily exposure, the healing of the mucosal defects showed no tendency to become chronic.

Lastly, in order to eliminate the possibility that the gastric juice of the patients with chronic ulcer might contain some substance which affects the healing of mucosal defects in

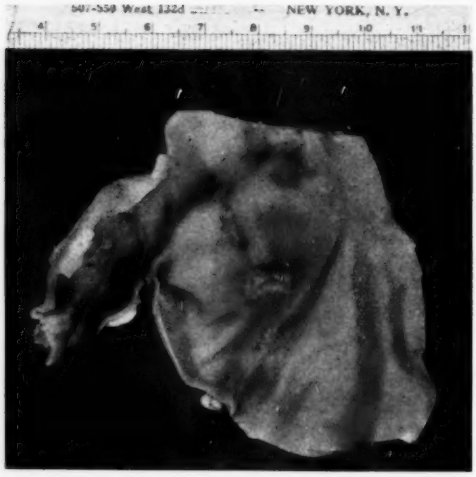

Fig. 2. Prepyloric defect in cat's stomach, showing effect per day for 7 days of 75 cubic centimeters of hydrochloric acid of hydrogen-ion concentration 1.2. The lesion is wider than in controls, but otherwise healing is normal.

such a way that chronicity results, two animals with prepyloric defects were given 75 cubic centimeters twice a day of gastric juice from patients with active peptic ulcer. The juice was taken during fasting and after histamine. One of these animals killed after 7 days of healing had a defect with a slight surface exudate, and the other was epithelialized after 14 days.

EVALUATION OF STUDY

Hydrochloric acid alone in high concentration has a destructive action upon a denuded area of the stomach and delays healing. Under the conditions of our experiments acid of a hydrogen-ion concentration of 0.9 was required. Delay was not obtained with a hydrogen-ion concentration of 1 or greater. The addition of pepsin, however, to the hydrochloric acid of the weaker concentrations was followed in some instances by marked tissue destruction and delay of healing. It appears, therefore, that gastric juice may have an injurious effect upon an open lesion of the stomach in two ways: by the direct corrosive action of the acid and by the digestive action of pepsin. The extent of the damage, of course, is dependent on the concentration of pepsin and acid in either case.

Anatomically, the picture in both instances is one of tissue necrosis and acute inflammatory reaction. When the necrosis is maximal, moreover, perforation of the stomach may occur as it did in several animals in our series. This necrosis is the cause of the delay of healing, for fibroplasia and epithelial regeneration, once started, were not prevented by continued corrosive or digestive actions. Thus although the acid plus pepsin and acid alone were given everyday, the regeneration of epithelium and fibrous tissue took place unabated from the seventh to the fourteenth day of healing.

No evidence was obtained which would indicate that gastric juice could cause an acute lesion in the otherwise normal stomach to become a chronic ulcer. Increasing the concentration of pepsin many times or the length of daily exposure of the lesion to

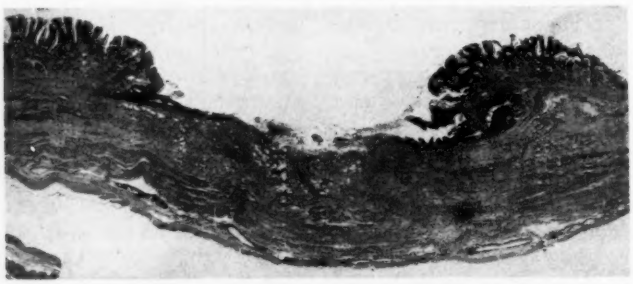

Fig. 3. Character of healing with two doses daily for 7 days, of hydrochloric acid of hydrogen-ion concentration, 1. Surface exudate is present but very small in amount. Spread of epithelium more extensive.

strong digestive juice did not result in a corresponding increase in the time required for healing to take place. It is possible, however, that ephedrine may have antagonized the effect of the gastric juice in some way. The experiments with the transferred gastric juice from patients with chronic ulcers suggests also that there is no mysterious substance secreted into the stomach of the patient which causes chronicity.

On the other hand, the failure of these experiments to produce chronic ulcers need not cast doubt upon the usual clinical concept of the causal relationship between gastric juice and the chronicity of ulcer. It must be remembered that the stomach has many ways of defending itself against the digestive action of gastric juice and that some of these were in no way disturbed by our methods. Thus, the length of time in which the juice remains in the stomach, its hydrogen-ion concentration and peptic activity are influenced by the intensity and frequency of the peristaltic waves, by the relaxation of the pyloric sphincter, and by the rate of neutralization by alkaline juices. Mucous and some living principle of the cell generally termed "antipeptic" are likewise involved. It is conceivable, therefore, that further interference with these protective mechanisms in the patient's stomach might account for a greater susceptibility of the open lesion to the action of pepsin and hydrochloric acid and explain the chronicity of peptic ulcers. That there is some relationship between the gastric juice and the chronic state of the peptic ulcer is suggested, of course, by the healing of some ulcers by therapeutic neutralization with alkalies taken by mouth and by the shortening of the emptying time of the stomach by surgical procedures. Furthermore, the human stomach with chronic ulcer

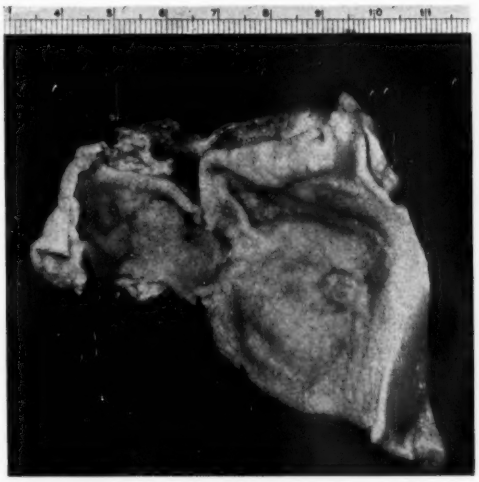

Fig. 4. Character of healing on the seventh day of a prepyloric defect in the stomach of a cat receiving 2 doses per day of artificial gastric juice of hydrogen-ion concentration, 1.2; pepsin, 4 per cent (1:10,000). Lesion was indurated. The gross appearance of the surrounding stomach suggests gastritis but histologically it was not present.

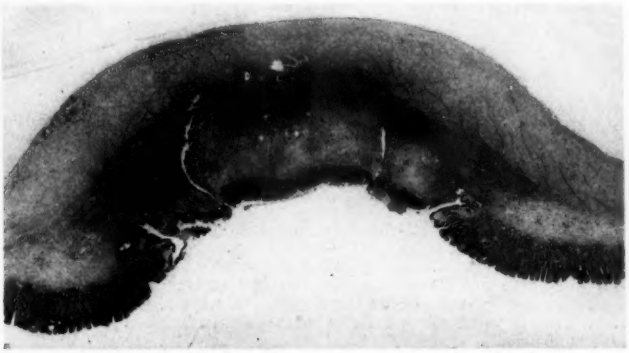

Fig. 5. Character of healing with 2 doses daily of artificial gastric juice for 7 days. Note extensiveness of surface exudate although the muscularis is not as deeply scarified as in Figure 3. Epithelium is beginning to regenerate on the left.

Fig. 6. Left, perforated prepyloric defect on seventh day following administration of 75 cubic centimeters of artificial gastric juice of hydrogen-ion concentration, 1.2, pepsin .4 per cent three times a day.

Right, 75 cubic centimeters of hydrochloric acid of hydrogen-ion concentration, 1.2, three times a day for 7 days. Healing is within normal limits.

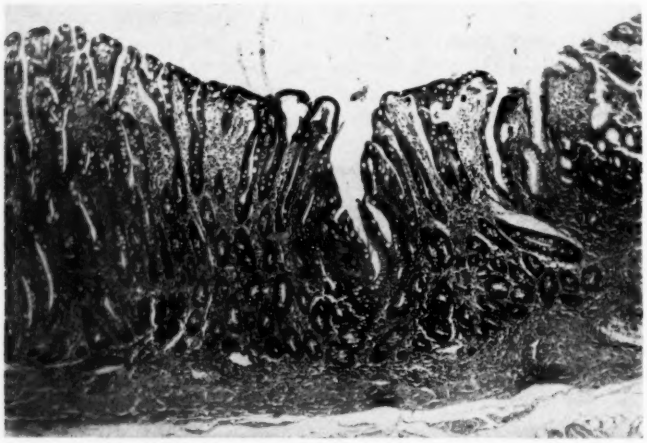

Fig. 7. Gastritis in human stomach at a distance of 5 centimeters from the margin of the ulcer. There are numerous goblet cells, the glands are arranged irregularly, and there is cellular infiltration. In spite of prolonged exposure to strong gastric juice, changes of this character have not been produced in the stomach of the cat.

shows general evidence of insult, and there is no data to indicate that this gastritis is not caused by some disturbed relationship between the corrosive and digestive activity of the content on the one hand and the protective mechanisms on the other. Konjetzny particu-

larly has demonstrated these inflammatory or degenerative changes at a distance from the site of the ulcer. We have recently reviewed the specimens of 25 gastric resections done for gastric ulcer at this clinic and have likewise found microscopic evidence of gastritis at a distance from the ulcer in 80 per cent (Fig. 7). There is also the possibility which must not be forgotten that this altered epithelium has less ability to regenerate in the presence of a potent digestive juice than has normal mucosa.

From the clinical standpoint, the importance of an enhanced peptic activity of the gastric juice in patients with ulcer is illustrated by the experiments, and recently the findings of Vanzant and his collaborators have indicated that these individuals actually have a high pepsin content in their gastric juice. However, these investigators found the increased amounts of pepsin in the patients with duodenal rather than gastric ulcers.

In conclusion, on the basis of our experimental evidence, we feel justified in asserting that pepsin and hydrochloric acid causes the acute necrosis seen in the floor of the ulceration and that this necrosis may become sufficient at times to result in perforation. On the other hand, with the methods used we were unable to obtain any evidence that gastric juice could cause an acute ulceration in an otherwise normal stomach to become a chronic ulcer.

CONCLUSIONS

1. Instillation of hydrochloric acid of a hydrogen-ion concentration of 0.9 into the stomach of the cat delayed but did not prevent healing of a mucosal defect. Acid of a hydrogen-ion concentration 1 or greater had little or no effect upon healing.

2. Pepsin combined with the weaker concentrations of acid, however, caused marked necrosis of the floor of mucosal defect, and although healing was delayed, ultimately it was not prevented.

3. The tendency toward chronicity in the healing of the defect was not increased either with longer exposure of the defect to pepsin-hydrochloric acid or by increasing the concentration of pepsin.

4. The delay in healing of the defect with pepsin hydrochloric acid or with strong hydrochloric acid without pepsin was caused by the acute necrosis of the floor of the defect. The regeneration of fibrous tissue or of epithelium once started was not prevented by repeated insults by these solutions.

5. The failure of these experiments to produce chronic ulcers does not invalidate the clinical concept of the causal relationship between gastric juice and the chronicity of ulcer for the defense mechanisms against the action of potent gastric juice were relatively undisturbed in these investigations.

6. The gastric juice of the patient with chronic peptic ulcer has no more capacity to cause an acute mucosal ulceration to become chronic than does artificial gastric juice.

7. In general, the experiments indicated that the stomach, even when injured, has the ability to cope with destructive digestive juices remaining in the lumen for long periods of time, provided the defense mechanisms are not too disturbed.

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A REVIEW CLINICAL AND PATHOLOGICAL OF PARAHYPOPHYSEAL LESIONS[1]

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GROUP VII. SUPRASELLAR FIBROBLASTOMAS

OF the intracranial fibroblastomas there are certain sites of predilection and of these may be mentioned the sagittal, the olfactory groove, the cerebellopontile angle, the sphenoid ridge, the suprasellar and the sylvian vessels. Illustrations of these abound in literature. In this display of parahypophyseal lesions, we must reserve for discussion, because of their proximity to the sella turcica and the hypophysis, the fibroblastomas which take their origin from the tuberculum sellæ. Grossly the fibroblastomas are solid, hard, and slowly growing. Often they compress the adjacent blood vessels, particularly the anterior cerebral, and sometimes they may be found actually to embrace both internal carotid arteries.

Microscopically, they are characteristic meningeal fibroblastomas, with a healthy amount of collagen and numerous fibroglia fibrils (Fig. 48). They are often psammomatous in structure and on rare occasions may even contain spots of calcium which throw a shadow in the roentgenogram. Fibroblastomas at the base of the skull are not as prone to invade the bone and to produce hyperostosis as those at the vertex. That they may do so, however, is seen in the case reported by Cushing and Eisenhardt, in which tumor cells were found in the bone in the region of the tuberculum sellæ. Such a complication is not common.

Unlike the stalk tumors, these fibroblastomas are attached to the sella only at one or two points, usually the tuberculum sellæ and the sulcus chiasmatis. When these attachments have been, it is possible to remove these tumors if they are not of too large dimensions. The dura underlying the tumors is usually infiltrated with nests of tumor cells, and, unless removed, offers a potential source for recurrences.

Because of its proximity to the optic nerves, impairment of vision is almost invariably the initial symptom of the suprasellar fibroblastoma. If not too much time has elapsed, impairment of vision, primary optic atrophy and the loss of one or both temporal fields may be, as in the cases which are about to be recorded, the only symptoms. As illustrating one of shorter duration (Case 14) and one of long duration (Case 15), the following 2 cases are cited.

CASE 14. A woman in her forty-second year noticed vision failing 18 months before admission. With no symptoms other than defective vision and loss of the right temporal field, a fibroblastoma, arising from the tuberculum sellæ, was found and removed. Vision on admission 1/30 and 6/30 and on discharge 6/9 in each eye.

Clinical history. C. M., a female, aged 42 years (File No. 29929), was referred to the neurosurgical service of the University Hospital October 3, 1934, by Dr. M. D. Bloomfield. Five years before admission the patient had nervous and crying spells and attacks of vertigo and nausea. These, however, were irrelevant, and in course of time disappeared. Eighteen months ago she noticed that her sight was affected first in her right eye then in the left. With the exception of some irregularity in her menstrual epoch, failing vision was the only complaint of the patient.

Examination. In every respect save her visual apparatus the physical examination was negative. In the roentgenogram the optic canals were normal. There were no signs of pressure, no atrophy of the clinoid processes. The sella turcica was not enlarged (Fig. 49), the basal metabolism was plus 1. The patient was a spare woman, weight 98 pounds, with no hypophyseal stigmas. Vision, right eye, 6/30; left eye, 1/30. Fields—right temporal hemianopsia, discs yellow and pale. No papilledema. Pre-operative diagnosis: suprasellar or sphenoidal ridge fibroblastoma.

Operation. Transfrontal craniotomy, right, October 13, 1934. Through a coronal incision there was exposed and removed a tumor which overlapped the anterior margin of the sella turcica and both optic nerves (Fig. 50).

Pathological diagnosis. Fibroblastoma.

Postoperative course. The patient made an uneventful convalescence and almost immediately after operation her temporal hemianopsia had disappeared. Her vision on discharge was 6/9 in each eye as compared with 1/30 and 6/30 on admission (Figs. 51 and 52).

[1]Conclusion of article in January, 1936.

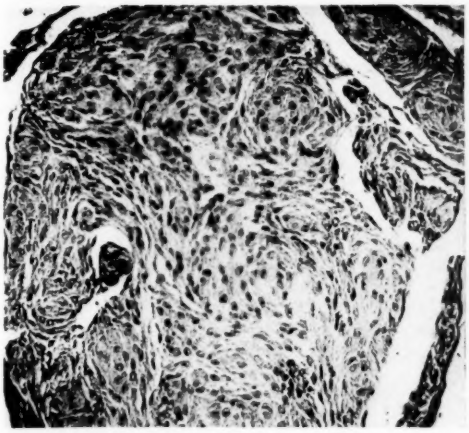

Fig. 48. A meningeal fibroblastoma from the suprasellar region showing the characteristic whorl arrangement. Hematoxylin and eosin stain.

CASE 15. A middle aged woman began to lose the sight of the right eye 6 years ago and in 4 years the vision in that eye was totally lost. For 3 years the sight of the left eye had been failing. Headaches are not a feature. Intense drowsiness 2 years ago. Left eye—temporal hemianopsia. Both discs were waxy yellow. A suprasellar fibroblastoma was found and removed.

Clinical history. E. J. B., aged 51 years (File No. 8215), was admitted to the neurosurgical service of the University Hospital April 28, 1926. She was well apparently until 6 years ago when the vision of her right eye became blurred and in the course of the following 4 years vision in this eye was completely lost (Fig. 53).

Three years ago a mist appeared before the left eye and now the patient can only distinguish large objects, as different pieces of furniture. She has had occasional pain in the right frontal region, but no headaches except when tired. During the past 2 weeks she had five attacks of nausea and vomiting.

Her menstrual flow has become scanty, she has lost rather than gained weight and for some 2 years she has at times been extremely drowsy. It was said that up to 2 years ago she had an excessive craving for meat.

Examination. The examination, with the exception of her visual defects and the appearance of the discs, was to all intents and purposes negative. The metabolic rate was plus 6. There was but a slight atrophy of the posterior clinoid processes but the pituitary fossa was well within normal limits, 7 by 10 millimeters.

Ocular findings. Both discs showed a waxy yellow atrophy with well defined margins. The right eye was blind. The temporal field of the left eye was lost and on the nasal side she could distinguish only large objects.

Fig. 49. Case 14. X-ray of sella turcica in a case of suprasellar fibroblastoma. Note sella not enlarged. Measurements, anteroposterior, 11 millimeters; depth, 9 millimeters.

Operation. May 10, 1926. Transfrontal craniotomy. No increased intracranial pressure. A hard, firm, encapsulated tumor the size of a plum was found directly over the sella (Fig. 54), which proved on examination to be a fibroblastoma. Subtotal removal. Convalescence uneventful.

Postoperative course. The patient's convalescence was uneventful and when last heard from, September 11, 1930, she was in excellent health though she had almost lost the vision of the left eye.

The suprasellar fibroblastoma takes its origin from the tuberculum sellæ, and as it increases in size the tumor stretches and separates the optic nerves and displaces the chiasm

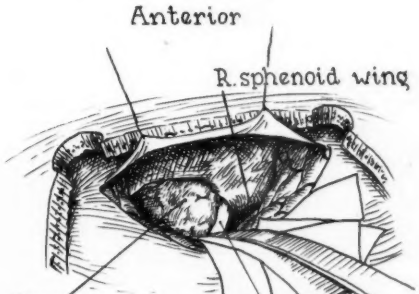

Fig. 50. Case 14. Drawing of tumor, as seen at operation, overlapping the anterior margin of the sella turcica.

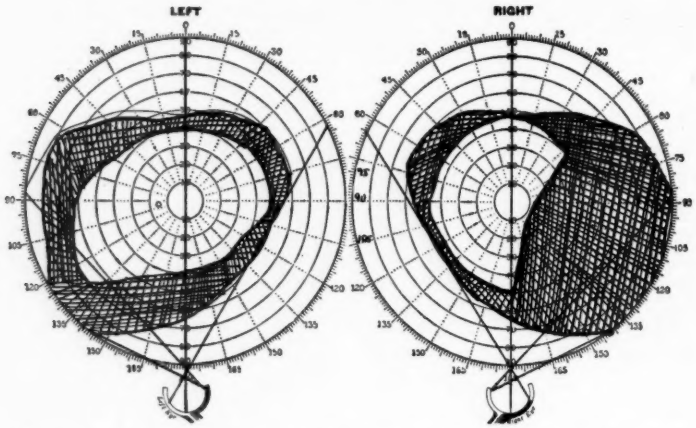

Fig. 51. Case 14. Fields before operation. Vision—left eye, 1/30; right eye, 6/30.

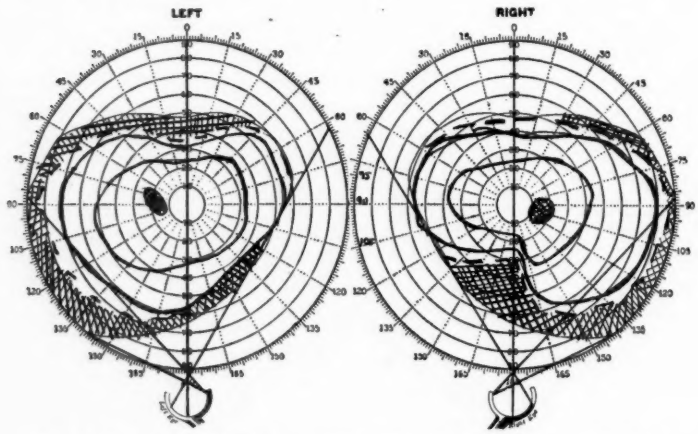

Fig. 52. Case 14. Fields after operation. Vision—left eye, 6/9; right eye, 6/9.

upward and backward. It is not associated, as are other fibroblastomas, with a hyperostosis, nor will the roentgenogram reveal any enlargement of the sella turcica.

Obviously when the lesion is not promptly recognized—and years may elapse before the tumor is exposed at operation or discovered at autopsy—the tumor may be sufficiently large to cause neighborhood symptoms and changes in the sella turcica. The latter may become eroded, there may be uncinate attacks, convulsions, evidence of hypophyseal dysfunction, and of hypothalamic damage. In a patient referred to by Holmes and Sargent, 11 years after beginning impairment of vision included in the picture were drowsiness, adiposity, increased sugar tolerance, headaches, dizziness, and vomiting, and the patient was completely blind. One patient of our series (Case 15) had for 2 years complained of drowsiness so intense that it was difficult for her to keep awake. In another (File No. 11447) there was definite evidence of hypophyseal dysfunction. In cases of more recent development (Case 14) there may be not the slightest evidence of an intracranial tumor

Fig. 53. Case 15. Patient with suprasellar fibroblastoma. The only symptom was blindness.

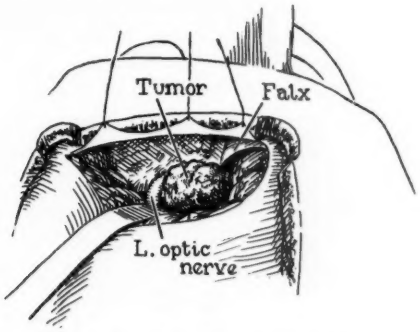

Fig. 54. Case 15. Suprasellar fibroblastoma exposed at operation. The left olfactory nerve has been divided.

other than that attributable to pressure upon the optic nerves and chiasm. This patient had no signs of hypophyseal dysfunction, there were no signs of increased intracranial pressure, there were no neighborhood symptoms, and the roentgenogram was normal.

How can these suprasellar fibroblastomas be differentiated from the other groups of parahypophyseal lesions? When it is a matter of differentiation from tumors of congenital origin, the stalk tumors, the teratomas, the tumor of Rathke's cleft, there should be little confusion, especially if one remember that these tumors of congenital origin occur chiefly in children and adolescents, that the X-ray often reveals calcified shadows and some deformity of the sella. The primary intrasellar adenoma has earmarks so characteristic that a mistake in diagnosis would seem unpardonable. On the other hand, the extrasellar or suprasellar adenoma may present a picture so like that of the suprasellar fibroblastoma that one may readily be mistaken for the other (see Case 16). Both occur in adults, in both the sella is not enlarged, in both primary optic atrophy and temporal field encroachment are constant. In neither may there be any evidence of hypophyseal dysfunction.

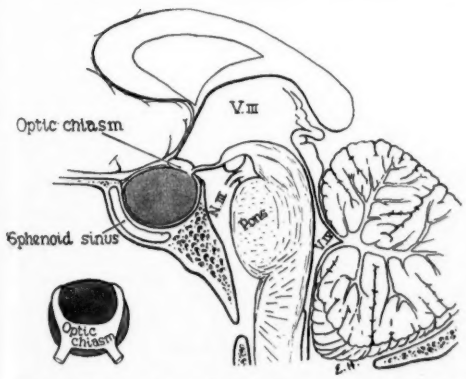

Fig. 55. Large intrasellar adenoma with typical sellar deformity, a large ballooned out sella, with erosion of anterior clinoids, encroachment on sphenoid sinus and compression of optic nerves and chiasm.

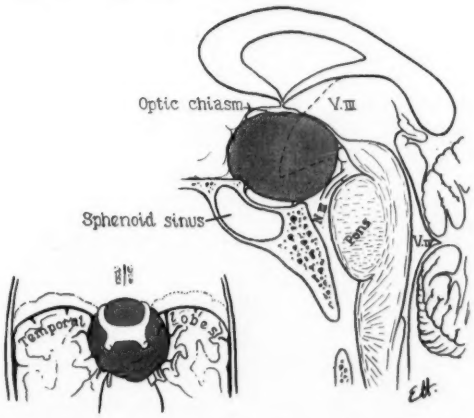

Fig. 56. A suprasellar adenoma showing compression of the chiasm with the anteroposterior enlargement of the sella turcica but no encroachment on the sphenoid sinus. The insert shows the tumor compressing the left oculomotor nerve and occupying the entire base of the brain between both temporal lobes.

Fig. 57.

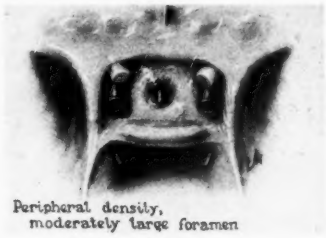

Fig. 58.

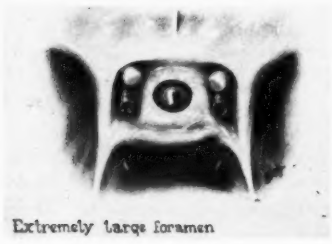

Fig. 59.

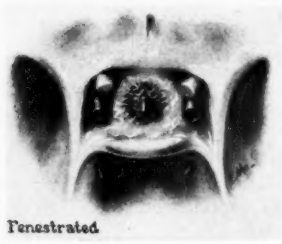

Fig. 60.

GROUP VIII. SUPRASELLAR ADENOMAS

The primary adenoma of the hypophysis is almost invariably an intrasellar structure and is readily recognized by the unmistakable ballooning of the sella turcica with the inevitable encroachment upon the sphenoid sinus (Fig. 55). But occasionally the adenoma—though precisely similar in structure—may occupy a superimposed position, extrasellar or suprasellar (Fig. 56). The upward rather than downward growth may be explained by the difference in the texture of the diaphragma sellæ. In his Bowman lecture, de Schweinitz referred to Schaeffer's review of the anatomy of this region and our attention was called to the great variation in the density of this diaphragm and in the size of its foramen. And so one can well understand how, when the diaphragm has a wide open foramen or a very loose texture or both, a growth from the hypophysis can make its escape from the sella turcica (Figs. 57, 58, 59, and 60). In the case we are about to cite the growth was in all respects a suprasellar one.

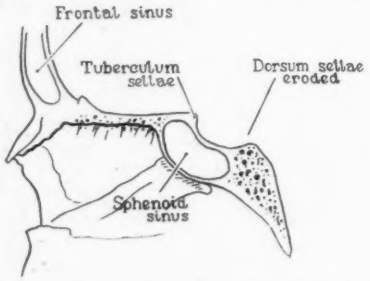

Fig. 61. Case 16. Drawing taken from the X-ray showing the sellar changes in the suprasellar adenoma: erosion of dorsum sellæ and posterior clinoids with an increase in anterior-posterior diameter of sella. There is no distortion of the floor and no encroachment on the sphenoid sinus.

CASE 16. A middle aged patient with an extrasellar adenoma in the course of 5 years lost the sight of the right eye and vision of the left is threatened. Both temporal fields were gone, the sella turcica was not enlarged, there were no endocrine stigmas. A cystic adenoma was found at operation and the contents evacuated. Eight years after the operation vision in his right eye had not deteriorated.

Clinical history. W. J. K., aged 48 years (File No. 4544 N. S.), was admitted to the neurosurgical service of the University Hospital November 29 and discharged December 28, 1924. For the past 5 years his eyesight had been failing. An examination revealed an optic atrophy which was said to be due to a septic focus. His tonsils and one tooth were removed. His accessory sinuses were X-rayed. Dr. William Zentmayer found a temporal hemianopsia in the left eye and in the right there remained only the

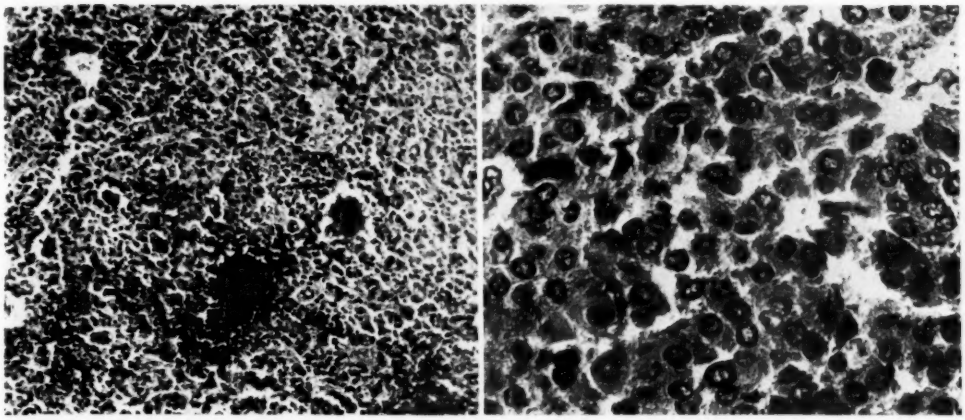

Fig. 62. A suprasellar adenoma showing tendency to columnar and acinar arrangement. The large chromophobic cells are seen in the high power.

superior nasal field. Originally there was, no doubt, a bitemporal hemianopsia. His vision first became impaired in the left eye but only 6 months ago did the right eye become involved, and not until he could not sight with his right eye, in shooting did he become concerned and alarmed. Occasionally he saw double, one object above the other, and occasionally too flashes of a white light in his temporal fields.

Examination. His blood pressure was 178/110 and his weight now and for the past 15 years 200 pounds. There were no hypophyseal stigmas. His vision in right eye was 6/22 and in left eye 1/60. The roentgenogram revealed almost complete destruction of the posterior clinoid processes without any depression of the sellar floor (Fig. 61).

Operation. Transfrontal craniotomy, right. Local anesthesia. In approaching the lesion the right olfactory nerve was divided. The right optic nerve and chiasm were freed from the capsule before it was incised. The contents, both solid and cystic, were evacuated.

Pathological diagnosis. Adenoma.

Postoperative course. At the time of the operation the patient was practically blind in the left eye, his vision in the right eye 6/22. When last seen 10 years after the operation there had been neither loss nor improvement in vision. The vision of the right eye was still 6/22 and his temporal field was still encroached upon.

Structurally the suprasellar adenoma differs in no respect from the intrasellar; these tumors may be both chromophobe and chromophile, wholly solid or, as in the case just cited, partly cystic (Fig. 62).

In one instance in our series, a chromophobe adenoma, the tumor was of unusual dimensions, wholly without the sella, occupying the entire space between both temporal lobes; it compressed the floor of the third ventricle and contiguous structures (Fig. 63).

As with intrasellar adenoma there may or there may not be associated hypophyseal symptoms. In one case there was none. Of the others, in one (File No. 20497) amenorrhea

Fig. 63. A large suprasellar adenoma can be seen filling the area between both frontal lobes, and compressing the base of the brain.

Fig. 64. Incision for transfrontal explorations.

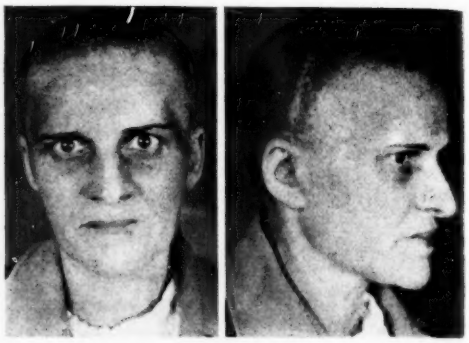

Fig. 65. Suprasellar fibroblastoma. Coronal incision.

was a significant symptom, in another (File No. 28058) acromegaly.

As with the suprasellar fibroblastoma, the sella turcica is not enlarged though the clinoid processes and dorsum sellæ may in part or altogether have atrophied. Should an encephalogram be made one's attention might be directed to a suprasellar lesion by the inability to visualize the cisterna chiasmatis.

Although the purport of this lecture is to present and define both from the pathological and clinical aspects the so called parasellar lesions, a word might be said about the method of exposure. In most instances we use what is called the transfrontal approach. Our technique for the procedure has been modified in many particulars in past years, but finally we have adopted the plan of making the scalp flap and the bone flap independently. From the standpoint of the cosmetic effect, we have found two incisions most acceptable. One begins 2 or 3 centimeters below the hair line in the midforehead and terminates just above the ear (Fig. 64). Thus, a unilateral flap, right or left as the case may be, is reflected and the incision is mostly within the hair line. More recently we have used with great satisfaction, and especially if the lesion be bilateral, what we have chosen to call the "coronal" incision (Fig. 65). This incision extends from the tip of one ear to the other and as it is wholly within the hair line the cosmetic effects are perfect.

SUMMARY

Thus have been presented these eight parasellar lesions differing from one another as to their nature and origin, as to their diagnosis and prognosis, and as to their treatment.

I. *Intracranial aneurisms.* From the circle of Willis come more than half of the intracranial aneurisms. The clinical history is more than suggestive, almost unmistakable, but only when there has been leakage. The sudden and intense headache with rigidity of the neck muscles, with fainting or unconsciousness in the presence of bloody cerebrospinal fluid, should always arouse one's suspicion. Of the focal symptoms, oculomotor paralysis and trigeminal pain in the ophthalmic division are the most constant. Periods of remission, of weeks' and months' duration, suffice to differentiate this parasellar lesion from tumor.

II. *Tumors of the optic nerve and chiasm.* Globular tumors, almost always gliomas, are found occasionally involving one or both optic nerves alone or with the chiasm. Mostly seen in children the diagnosis is speculative unless by the roentgenogram one finds the optic foramina enlarged and the anterior section of the sella turcica expanded forward. Primary optic atrophy and field defects are inevitably associated with loss of visual acuity. They do not lend themselves to surgical treatment.

III. *Tumors of the lesser wing of the sphenoid.* Since the number of arachnoid villi from which the fibroblastoma takes its origin are more numerous in the base of the skull, this tumor is most frequently found in the

sellar and parasellar regions. One of the sites of predilection is the lesser wing of the sphenoid, variable in size, sometimes crawling forward over the anterior fossa, sometimes backward into the middle fossa. Definitely unilateral, their recognition will not be difficult when primary optic atrophy, homonymous field defects, with or without oculomotor paralysis, are associated with unilateral structural alterations in the bony anatomy of the sella turcica as depicted in the roentgenogram. There may be neighborhood symptoms, disturbance of the sense of taste, hypophyseal stigmas, occasionally paralyses and reflex symptoms due to pressure on the middle and anterior cerebral arteries.

IV. *Pseudotumors*, a term introduced by Nonne to designate a circumscribed collection of fluid, synonymously spoken of as meningitis circumscripta, arachnoiditis, are seen occasionally in the suprasellar region. Except possibly by the pneumogram, which may portray a filling defect of the cisterna chiasmatis, the verification of this lesion is not made until exposed on the operating table. With a bitemporal heminanopsia, with some enlargement of the sella turcica, primary optic atrophy, and signs of hypophyseal dysfunction, pseudotumors may so mimic a solid tumor of hypophyseal origin as to be indistinguishable before exposure by operation. The results of surgical treatment are surprisingly good.

V. *Tumors of Rathke's cleft.* The term Rathke pouch tumor is a misnomer and has been loosely used to include most congenital tumors in this region. The tumors under consideration do not arise from Rathke's pouch, which, in the process of evolution from an invagination of the buccal cavity, becomes the anterior lobe of the hypophysis. They arise from Rathke's cleft. Essential to the diagnosis of these tumors is a layer of ciliated epithelium on the wall of the cyst. Rather than being relatively common, as one might judge from the literature, these tumors we believe are indeed rare if our proposals as to their identification be accepted. Mostly in the adult, usually cystic, sometimes within and sometimes without the sella turcica, one cannot with any degree of certainty establish the diagnosis before tissue has been removed at operation for histological study. The tumor is readily dealt with by the surgeon and the end-results may be excellent.

VI. *Hypophyseal stalk tumors.* The term craniopharyngioma should be disbarred from the nomenclature as indicating tumors that take their origin from the anatomical remnant of the original communication with the buccal cavity. These tumors have nothing to do with the pharynx, hence the term craniopharyngioma is altogether inappropriate. In substitution we introduce the term "hypophyseal stalk tumors," a term with a correct anatomical implication. The stalk tumor may originate from one of two epithelial anlagen, an upper and lower nest of cells. If from the upper nest they soon encroach upon the third ventricle with the usual consequences of an obstructive hydrocephalus, headache, vomiting, papilledema; if from the lower nest, pressure on the chiasm, primary optic atrophy, structural alterations about the sella turcica result. With a histological picture in which a basilar layer of ameloblastic cells is a characteristic feature, the stalk tumor affects the child and the adolescent, is prone to undergo cystic degeneration, with numerous areas of calcification. In the differential diagnosis one must have in mind another congenital tumor, the teratoma.

VII. *The suprasellar fibroblastoma.* In its microscopic picture similar to fibroblastomas elsewhere one must distinguish the fibroblastoma that springs from the tuberculum sellæ, the suprasellar fibroblastoma, from those which spring from the olfactory groove or the sphenoidal ridge. Insidious in onset, slow in growth, primary optic atrophy with progressive loss of vision until blindness ensues may be the only distinguishing features.

VIII. *The suprasellar adenoma.* Comparable in its histological structure in every particular to the intrasellar hypophyseal adenoma occasionally the adenoma of the hypophysis may grow wholly without the confines of the sella turcica, hence designated suprasellar. Lacking the ballooning of the sella turcica, the inevitable accompaniment of the common intrasellar adenoma, the suprasellar or extrasellar adenoma cannot be identified before operation from any other lesion of comparable size and

of a common site. The congenital stalk tumors are more common in children, the adenoma after the twentieth year, and the fibroblastoma after the thirtieth year.

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REGENERATION OF THE SEMILUNAR CARTILAGE

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THE normal knee joint function one generally observes following semilunar cartilage extirpation still arouses some curiosity. Is it because the meniscus is an unnecessary anatomical structure, or does regeneration of the extirpated cartilage occur? Sir Robert Jones, in replying to the question, What takes the place of the cartilage, made the following statement: "In cases that have come to me with the history of removal of a cartilage, I have found no trace of any new structure even 10 years after operation."

A. G. Timbrell Fisher states: "The author (Fisher) has operated upon several cases for recurrence of symptoms after operation 'elsewhere,' and has never seen any evidence of regeneration of cartilage sufficient to bring about recurrence of symptoms."

Other authors, on the contrary, have reported instances of what they considered regeneration. For example, Mandl reports 3 patients who had had a partial extirpation of the internal semilunar cartilage. Because of persistence of symptoms two of these joints were reopened 6 and 8 months later, and the extirpated portion was found to have regenerated. The third patient died of intestinal carcinoma 3 years after the knee joint operation. Postmortem examination showed a complete regeneration of the resected portion.

Moeller cites the case of a 20 year old man whose medial meniscus was excised in 1925. Four years later the knee again locked and was reopened. There was found a flat "meniscus-like" piece of tissue which was firmly fixed anteriorly and posteriorly where the normal meniscus is attached, but loose in its midportion. This tissue was excised and on microscopic examination was found to be connective tissue.

Gibson relates a case in which a patient was operated upon by another surgeon for symptoms of internal derangement of the knee, and, as the symptoms recurred, Gibson again operated and found the internal semilunar cartilage *in situ*. He assumed that the cartilage had been extirpated at the original operation and had regenerated.

This problem has also been attacked from the experimental side. Pfab (8) extirpated

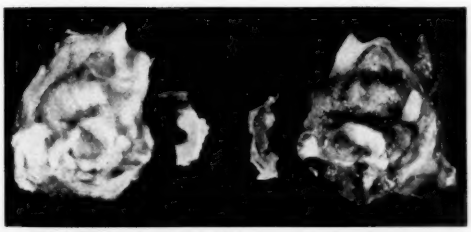

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 1. Dog 1, 14 weeks after operation. Left, Note complete semilunar disc of glistening white tissue replacing extirpated cartilage of left knee. Note marked synovitis, complete disc of tissue replacing extirpated cartilage of right knee.

Fig. 2. Dog 2. Left, Complete semilunar disc of glistening white tissue, granular degeneration of articular cartilage (medial condyle) of left knee. Note somewhat better replacement, less articular cartilage degeneration of right knee.

Fig. 3. Dog 3. Left, Note narrow band of tissue replacing semilunar disc, also granular degeneration of articular cartilage of left knee. Right knee same as left.

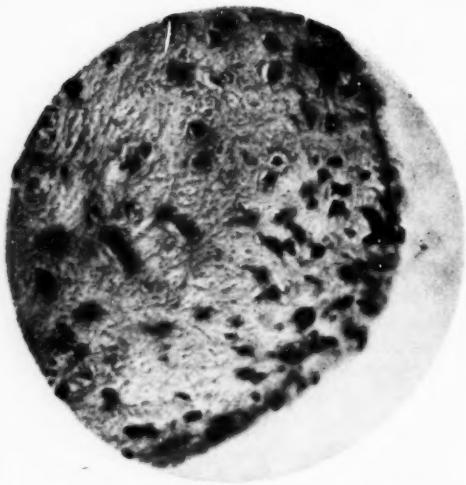

Fig. 4. Photomicrograph through medial edge of tissue replacing extirpated semilunar cartilage Dog 3 (right side). Note cells suggesting cartilage.

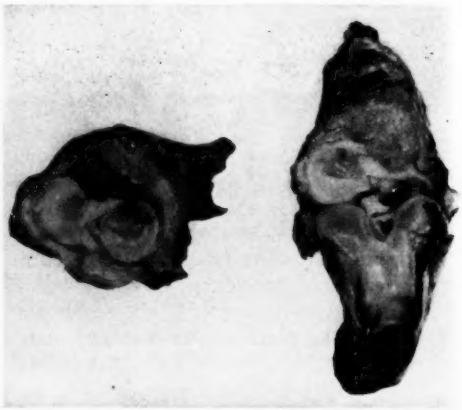

Fig. 5. Dog 4. Left, Note replacement following extirpation of anterior one-fourth of the cartilage of left knee (8 weeks). Replacement of excised section of cartilage of right knee.

the semilunar cartilage of three sheep's knees. Six months later the synovial membranes were thickened, and through their proliferation a new tissue much like a meniscus was formed. The same author (9) working with rabbits extirpated one meniscus, both menisci, and in some instances the menisci plus the cruciates. In 3 cases, there was a slight tendency for the semilunar cartilage to be regenerated, in 3 others no regeneration occurred, and in another instance there was a fair regeneration.

Gibson operated upon 2 dogs doing a partial extirpation of the internal semilunar cartilage. Five months later one of the joints showed an apparent complete restitution of the extirpated portion.

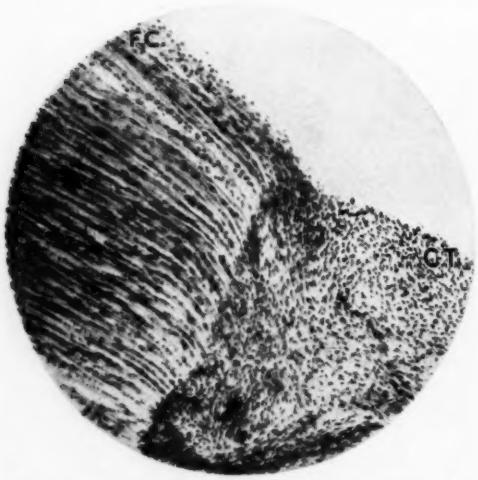

Fig. 6. Dog 4. Abrupt transition from fibrocartilage (left) to connective tissue (right) which apparently does not originate from the fibrocartilage.

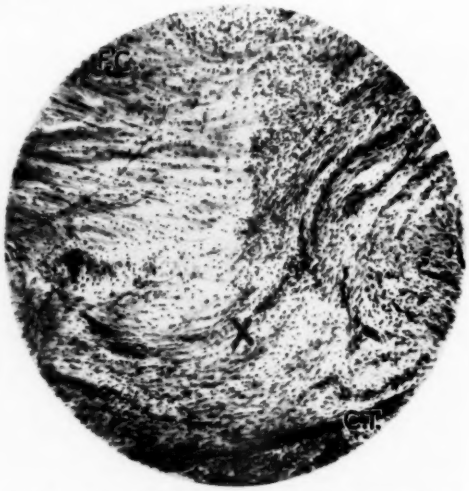

Fig. 7. Dog 4. Further lateral to show connective tissue sweeping in from peripheral attachment of the disc (*X*) and not arising from the fibrocartilaginous stump.

Dieterich extirpated small portions of the semilunar cartilages (dogs) and found the defects filled in with a "tendon-like" tissue, which contained no cartilage. Associated with this in most instances was a severe proliferating synovitis.

Fiorni extirpated the external semilunar cartilages from the knee joints of 14 rabbits. The joints were immobilized for 20 days following operation. The joints were examined at varying periods of time and in many instances the extirpated cartilages had been replaced by connective tissue.

Counting Gibson's case, there are reported in the literature at least 5 cases of regeneration of an extirpated semilunar cartilage. Laboratory experiments up to this time have shown a replacement by connective tissue, rather than a true fibrocartilaginous regeneration.

The object of this paper is to report our experimental work on this subject.

EXPERIMENTS

The dogs will be considered individually in the order in which they were operated upon. All dogs used were adults.

Dog 1. On January 7, 1935, a subtotal excision of the internal semilunar cartilage of the left knee was performed, a short curved incision being employed. On the right side about one-half of the cartilage was removed. A cast was applied to the left leg which was removed on the eleventh postoperative day. A few days after the operation the function of the limbs appeared normal. Fourteen weeks after operation the dog was killed and the knees opened (Fig. 1). On the left side the joint interior appears normal. There is a complete regeneration of a circle of glistening white tissue the morphology of which is not unlike that of a real semilunar cartilage. There is a slight granular degeneration of the articular hyaline cartilage.

On the right side there is a marked synovitis with considerable clear, synovial fluid in the joint. The external semilunar cartilage has lost its luster, is striated longitudinally, and is degenerating. In spite of this marked synovitis, there is a replacement of the internal cartilage by a complete semicircle of non-glistening tissue. There is here also a granular degeneration of the articular cartilage.

Microscopic study of the new-formed tissue (left side) shows a compact connective tissue but no cartilage cells.

Dog 2. On January 8, 1935, both internal semilunar cartilages were excised *in toto* and on the left leg a cast was applied. This had to be removed in 3 days' time because of swelling and apparent discomfort.

On March 26, 1935, 11 weeks later, the dog was sacrificed and the knee joints opened. There was no increased synovial fluid; no synovitis.

On the left side (Fig. 2), there was a complete semicircle of a narrow band of glistening white tissue which grossly appeared exactly like the opposite semilunar cartilage. It was considerably narrower than the extirpated cartilage. Posteriorly it was well attached to the posterior cruciate ligament, anteriorly to the transverse ligament and laterally to the synovial membrane. There was granular degeneration of the articular hyaline cartilage.

On the right side regeneration had taken place to an even greater extent.

Microscopic sections made through the apparently regenerated cartilage revealed a compact fibrous tissue but no evidence of cartilage. Section through the articular cartilage showed fraying and degeneration of its superficial surface.

Dog 3. On January 11, 1935, a bilateral complete extirpation was done, a cast being applied to the left leg. In 1 week's time the cast was removed.

On April 18, 1935, (14 weeks) the dog was killed and the joints opened. On the left side (Fig. 3) there was a very mild synovitis with slightly increased fluid in the joint. On both sides there was a complete, but very narrow, horseshoe of regenerated tissue which looked like fibrocartilage. Both sides showed hyaline cartilage degeneration on the lateral condyles.

Sections cut transversely through the regenerated tissue on the right side showed a well developed connective tissue. In places, however, one could make out slightly bluish areas suggesting cartilaginous matrix and in other places a few cells which looked like cartilage (Fig. 4).

Dog 4. On January 21, 1935, the anterior one-fourth of the left internal semilunar was excised and on the right side a cuneiform section, measuring 4 millimeters externally, was removed just anterior to the internal lateral ligament. No fixation was employed.

On March 22, 1935, (8 weeks) the dog was killed and the joints opened. Grossly the joints appeared practically normal. On the left there appeared to be a complete regeneration of the anterior one-fourth of the fibrocartilage, and on the right side the gap was filled in with a tissue which was grossly fibrocartilage.

Sections at the junction of the fibrocartilage (Fig. 6) with the newly regenerated tissue showed an abrupt transition from fibrocartilage to connective tissue. The new tissue consisted entirely of connective tissue, there being no cartilage cells present. It apparently originated entirely from the connective tissue of the synovial membrane laterally (Fig. 7), since there was no evidence that connective tissue was growing out from the fibrocartilaginous stumps.

SUMMARY

A complete extirpation of the internal semilunar cartilage was done on 4 knee joints, subtotal extirpation on 2, and partial excision on 2 others. In 3 cases the joints were immobilized for 11, 7, and 3 days' time. The joints were reopened 8 to 14 weeks later. In every case the extirpated cartilage was replaced by a semilunar disc of firm glistening tissue which grossly was similar in every way to true fibrocartilage. Microscopically this was found to be connective tissue. In 1 case a few cells, suspiciously like cartilage, were seen.

Granular degeneration of the articular cartilages of the medial tibial and femoral condyles was a uniform finding in each of these experimental cases.

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AMNIOTIC FLUID CONCENTRATE AS AN ACTIVATOR OF PERITONEAL IMMUNITY[1]

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A CONSIDERABLE and sustained mortality and morbidity from postoperative peritonitis brings forcibly to our attention the inadequacy of established methods in dealing with this problem. Notwithstanding the high degree of perfection attained in our aseptic and antiseptic technique we are still confronted by the specter of infection following surgery of the serous cavities.

In our attempt to meet this situation we find a very promising possibility in immunization of the peritoneal cavity by the operative or pre-operative introduction of a stimulating agent.

It is now definitely established, both clinically and on experimental animals, that the introduction of certain foreign substances into the peritoneal cavity will excite the production of a defense exudate. The contents and volume of this exudate will be determined to a large degree by the character and amount of the substance introduced. Generally, this exudate may be said to contain serum, leucocytes, erythrocytes, fibrin, lytic ferments, opsonins, and other antibodies, and, presumably, a host of unknown substances which influence the processes of defense and repair. However, such activation of the peritoneal defense mechanism should not be attained at the risk of destructive irritation. A stimulation threshold exists beyond which one cannot go without causing tissue damage. The level of this threshold shows a wide individual variability and may be observed in the experimental animal and in operative procedures on human patients who have received pre-operative instillation of a stimulating agent (16). Where the optimum reaction to the activating agent does not exceed the level of the stimulation threshold, the exudate is usually pink in color, slightly murky, and contains considerable fibrin. The differential exudate white cell count will be preponderantly neutrophilic and the sediment will show comparatively few erythrocytes or mesothelial cells (Fig. 1). If the level of the threshold is exceeded we see reaction in proportion to the excess. In these latter cases the exudate is hemorrhagic; the primary neutrophilic preponderance, common to most acute peritoneal exudates, is soon replaced by the large, wandering cells (so called histocytes) and the exudate sediment shows an abundance of erythrocytes and cell detritus. The systemic reaction serves as a further guide in determining the irritating effect of a given agent. This may vary from no reaction at all, as in the case of innocuous substances, up to a severe local and systemic disturbance in the use of the more active irritants. In these latter cases intraperitoneal injection is followed by local pain, tenderness, and a varying amount of abdominal distention, fever, malaise, anorexia, and the upset of body chemistry common to such reactions.

The history of abdominal surgery is replete with attempts to modify or prevent postoperative adhesions, but comparatively little attempt has been made to establish a harmless, reliable method of peritoneal immunization, in fact there are only two agents in common use for this purpose (6, 10, 13).

Substances proposed for the prevention of postoperative adhesions would concern us little in this paper were it not for the danger attendant upon their use. The greatest risk lies in their introduction in cases likely to develop postoperative infection. Such agents as papain (8) or pepsin (15) which are said to accomplish the prevention of peritoneal adhesions through the digestion of fibrin are admittedly destroying a first line of defense, fibrin being a most important element in the peritoneal defense mechanism through its part in localizing infection and preventing absorption of bacteria and their toxins (4). Other

[1]Read at the Faulkner Hospital, Boston, Massachusetts, before the Clinical Congress of the American College of Surgeons, October 18, 1934.

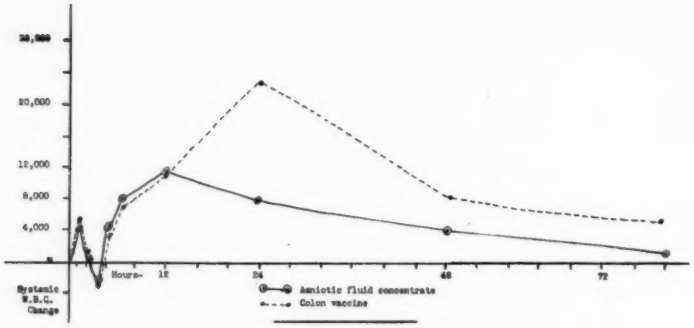

Chart 1.

agents such as hypertonic glucose (1) and sodium ricinoleate (11), which call forth the production of a tremendous peritoneal transudate are a distinct menace in the presence of postoperative infection, since they too, defeat the all important process of localization. In the case of sodium ricinoleate, there is also widespread cell disruption (Fig. 28).

The elements of defense and repair contained in the peritoneal exudate bear a normal relation to each other in their defense activities (9). This interdependence is of the utmost importance in carrying out the whole process of immunity and repair. Any agent which upsets this normal order of action by stimulating one part of the defense mechanism at the expense of another, or by destroying one or more parts of the whole, is obviously detrimental and its use is difficult to justify.

As a harmless but effective activator of peritoneal immunity we use a purified, concentrated, bovine amniotic fluid (7). In our early work with amniotic fluid our efforts had to be confined to cases of abdominal cesarean section, since these were the only operations at which a supply of the fluid in a reasonably sterile condition was available. In a small series of cases, over a period of 4½ years, the results were so satisfactory as to justify the use of this agent in abdominal operations other than cesarean sections. Further, to establish the efficacy of this substance as an activator of peritoneal immunity, a small series of laboratory animals were used and our combined observations were published in 1927 (6).

An essential to the extended application of this new technique was the establishment of an ample and reliable source of supply of the whole fluid and a method of purification which would render the end product practically innocuous. For this purpose bovine amniotic fluid was selected. By a process of concentration, fractionation, and purification, certain proteins, serum albumins, lipoids, and other potentially harmful substances are removed from the whole fluid. The end product we refer to as amniotic fluid concentrate.[1]

In 1929, Rankin and Bargen reported a series of clinical cases in which they used a bacterial vaccine made from cultures of colon bacillus and streptococci (10). This agent was employed for pre-operative peritoneal immunization only. Steinberg and Goldblatt observed the action of this vaccine to be nonspecific and have modified its preparation by suspending the killed colon bacilli in a 1 per cent solution of gum tragacanth (13). Since bacterial vaccines and amniotic fluid concentrate are the only two agents in common use, as activators of peritoneal immunity, their respective merits will be referred to in some detail.

A total of 70 dogs were used in an experimental study of the basic principles of peritoneal immunization. The local and systemic effects of amniotic fluid concentrate and colon bacillus vaccine when introduced into the peritoneal cavity were checked by the use of

[1]Grateful acknowledgment is made to the Eli Lilly Company for their valuable assistance in the preparation of amniotic fluid concentrate and for an abundant supply of this product for clinical and laboratory trial.

TABLE I.—SUMMARY OF PERITONEAL REACTION IN 40 NON-INFECTED CASES

Substance	Average systemic W. B. C. optimum rise	Time to optimum reaction	Character of exudate	Average exudate W. B. C.	Fibrin	Peritoneum	Clinical course following injection
Amniotic fluid concentrate	12,000	6–12 hours	Clear, thick blood tinged	75,000	High	Pink, smooth injected	Mild reaction, no apparent discomfort
Colon vaccine	24,800	48–72 hours	Bloody murky, dark	120,000	Very slight	Hemorrhagic, markedly injected	Uncomfortable for 24 to 48 hours. Often severe reaction
Control—normal saline	8,000	6–12 hours	Thin, blood tinged	15,000	None	Pink, moderately injected	Mild reaction, no apparent discomfort
Merthiolate and normal saline	12,000	6–12 hours	Thin, blood tinged	22,000	None	Pink, moderately injected	Mild reaction, no apparent discomfort

control substances, such as normal saline, papain, merthiolate in normal saline, and sodium ricinoleate. The animals were divided into two main groups, infected and non-infected. Taking the non-infected group first we noted the systemic and local reaction to colon vaccine, amniotic fluid concentrate, normal saline, and merthiolate (1: 20,000) in normal saline. In a small number of animals we tried added control checks with papain and sodium ricinoleate. In the infected group we used colon vaccine, amniotic fluid concentrate, merthiolate in normal saline, papain, and further controlled the experiments by the use of untreated animals. Observations on both groups were made through the medium of systemic and exudate white counts (total and differential), fibrin content of the exudate as determined by clotting, peritoneal sections and smears, cultures, and the clinical course of the animals. With suitable allowance for the wide individual variability common to dogs, and for the difficulty of maintaining a standard of virulence in the bacteria used, we were able to make some fairly consistent findings over the entire group.

Our first observation was the immediate clinical reaction of the animal to the agent used. In the case of the amniotic fluid, normal saline, and merthiolate animals no immediate or remote discomfort was noted. These dogs were practically as well at any interval following the intraperitoneal injection of these substances as before their use. The animal receiving sodium ricinoleate gave evidence of great pain during the process of injection and was sick and very uncomfortable until sacrificed at 12 hours. In the dogs receiving colon bacillus vaccine, a rather severe local and systemic reaction was noted. They seemed to be in considerable distress as evidenced by whining, restlessness, anorexia, and malaise. There was also noted varying degrees of abdominal distention. This condition lasted usually from 24 to 48 hours. One dog was in such pain immediately following the introduction of the colon vaccine preparation that the use of morphine was necessary. Three of these uninfected colon vaccine dogs died before the usual 48 hour immunization interval had elapsed and autopsy failed to reveal the cause of death. Cultures of the vaccine used were negative.

Our next observation was the systemic white count (Chart 1). These tests were made when the dog was received, previous to any medication or manipulation, and again at the time of each peritoneal inspection. In the infected animal, it was made before the introduction of living bacteria and at the time of the postmortem examination, whether the animal died or was sacrificed.

In both the infected and non-infected group, the systemic white count was much higher in the colon dogs than in the amniotic or control dogs. The slight initial rise and fall was fairly constant in all animals and probably marked the stage of sudden withdrawal of leucocytes from the blood stream to meet a local emergency. Dogs receiving amniotic fluid concentrate reached the peak of their systemic white count at 12 hours, while colon vaccine animals continued to rise for 24 hours. In each case gradual recession followed until at the end of 72 hours the count in the colon animals exceeded that of the amniotic fluid concentrate animals by about 25 per cent (Table I).

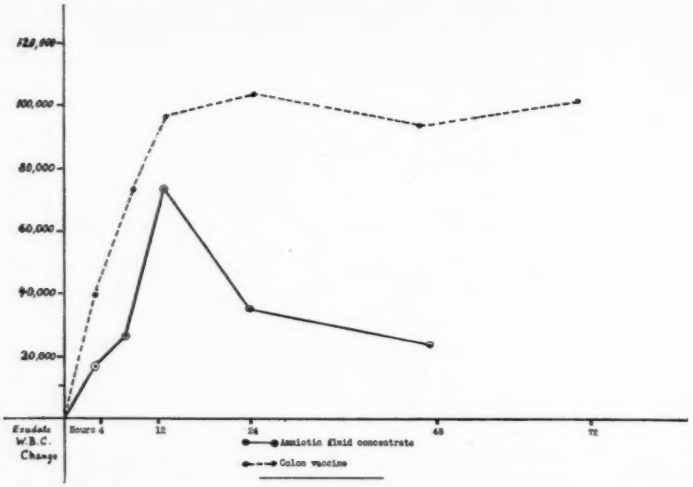

Chart 2.

When the peritoneum was opened we observed the amount and character of the exudate. Color, consistency, white cell count (total and differential), clotting, and cell detritus were the main points checked in making the comparison. The condition of the peritoneum was noted grossly and sections were taken for microscopic examination.

All exudates showed a degree of redness ranging from a light pink, in the animals in which amniotic fluid and saline were used, to a heavy, blood red in the dogs in which the colon vaccine was used. The consistency of the exudate was largely dependent on the fibrin content. This was determined roughly by the amount and speed of jelling. In every instance, the peritoneal exudate in the amniotic fluid animal jelled solidly in from 3 to 5 minutes and, in 1 dog, 4 hours after the introduction of amniotic fluid concentrate, the exudate jelled in the stem of a large syringe within the abdominal cavity. The differential white cell count of the exudate in all animals was characterized by an early preponderance of neutrophilic leucocytes. Following this primary reaction to the stimulating substance the neutrophilic leucocyte count receded and the larger phagocytic cells, so called histocytes, invaded the field in increasing numbers. The animals receiving colon vaccine gave the highest average total white cell count (Chart 2). Taking this exudate white cell count as a guide, we observed that the optimum reaction in the colon series occurred at approximately 24 hours and was sustained for 48 to 72 hours. At about the 24 hour period, there was a definite recession of the neutrophiles and a tremendous increase in the histocytes (Figs. 17, 18, and 19). In the amniotic concentrate animals, optimum reaction was obtained in approximately 12 hours and was followed by an immediate recession of the total white cell count if infection or further stimulation were not introduced. A relatively small number of histocytes was noted. If the number of exudate white cells induced by a given agent were an index of the animal's immunity when infec-

TABLE II.—INFECTED CASES—27 DOGS

	No.	Per cent
Lived	18	70
Died	9	30
Amniotic fluid concentrate—8		
Lived	7	87.5
Died	1	12.5
Colon vaccine—9		
Lived	6	66.6
Died	3	33.3
Controls—8		
Lived	5	62.5
Died	3	37.5
Merthiolate and normal saline—2		
Lived	1	50
Died	1	50

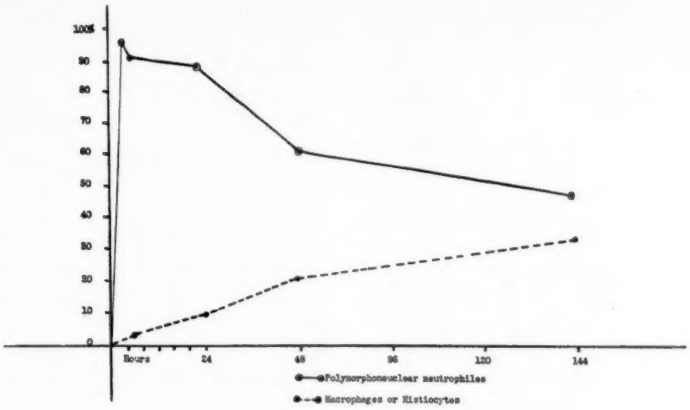

Chart 3.

tion was superimposed, it would serve as a strong recommendation for the use of the selected agent. Such, however, is not the case. In fact, the percentage of recoveries of infected animals protected by amniotic fluid concentrate was higher than in the case of animals protected by any other substance (14) (Table II). In the control animals treated with normal saline and merthiolate in normal saline, the exudate white count averaged 15,000 to 20,000, respectively (Fig. 3). The protection in these animals was very transient.

In normal, untreated dogs we found no exudate and no peritoneal white counts. Smears of the normal peritoneum showed an abundance of healthy mesothelial cells (Fig. 4). The complete absence of other cellular structures is interesting in view of the fact that Dickson and Rixford claim a normal intraperitoneal white count of 23,000 per cubic millimeter in the human with histocytes forming 45 per cent of the total. When we consider that the human cases from which these deductions were drawn were sufficiently pathological to require surgical intervention, it may account, in part at least, for the discrepancy between the human cases and our laboratory animals. These investigators further suggest that the preponderance of histocytes found in the exudate of cases receiving colon vaccine, 48 to 72 hours before operation, are the most effective part of the defense mechanism and the beneficial effect derived from the use of colon vaccine, before operation, is due to their activity. This is contrary to our observations.

Figures submitted by Smith in his attempt to immunize rabbits by the intraperitoneal and subcutaneous injection of streptococcus antitoxin are in keeping with our own conclusions on this point. A chart plotted from Smith's figures shows a rapid rise of neutrophiles in the first 2 hours to about 96 per cent of the total white cell count with gradual recession, over a period of 5 days, to about 50 per cent (Chart 3). During this period there is a gradual rise of the histocytes to about 30 per cent of the total. It is our observation that histocytes are super-phagocytes and come into the picture late in response to the influence of dead tissue. Smith's findings, together with our own, suggest that there is some basis for this conclusion. Contrary to this usual relationship, however, it is not uncommon to see an abundance of histocytes and neutrophiles in the same field where the infection or irritation has been severe and long sustained (Fig. 5). This fact alone suggests that local immunity cannot be measured in terms of the total or differential exudate white cell count. Other factors, chiefly humoral, play a most important part (9).

The technique employed for superimposing infection in the vaccinated and control animals was varied. In the first three series colon vaccine, amniotic fluid concentrate, normal saline solution, and untreated control dogs

were used. A method proposed by David and Loring was followed, in which the agar slant with its 24 hour culture of living bacteria was placed in the peritoneal cavity through a small abdominal incision. In the remaining animals we used the method of Steinberg and Goldblatt, introducing the living organisms in 40 cubic centimeters of a 2.5 per cent gum tragacanth solution by the use of a needle and syringe. In a single dog 50 cubic centimeters of an exceptionally heavy concentrate of colon vaccine (four billion per cubic centimeter) in normal saline was used for the purpose of comparing local and systemic reaction as well as the degree of immunity when infection was introduced 48 hours following vaccination (Fig. 6). It was our impression that this animal did generally better than the average colon vaccine dog. In a single series of 4 dogs comprising animals treated by amniotic fluid concentrate, colon vaccine, papain, and the untreated control dog, 50 cubic centimeters of a virulent culture of colon bacilli and streptococci was injected intraperitoneally in each treated animal at the same time the immunizing agent was introduced. The untreated control animal received a similar amount of the infecting agent. In the case of the colon vaccine animal, death followed at 12 hours; the papain animal died at 15 hours and the amniotic concentrate and control animals survived the infection. The amniotic concentrate dog was quite sick for 24 hours following which improvement took place until he was sacrificed at 48 hours for the purpose of obtaining smears and tissue sections. The control dog continued very sick up to the 48 hour period at which time he also was sacrificed for comparative study. This experiment was an interesting observation on the protective value of the agent used when infection was introduced at the time of peritoneal vaccination, but it was not repeated because no claims are made for the protective value of colon vaccine or papain when employed in this manner.

A comparative study of the peritoneal smears and sections of the infected and uninfected groups gives some idea of the physiology of the peritoneal defense mechanism and demonstrates the variations of the classical reaction that occur in response to the use of certain substances.

Standard textbook description (9) of the reaction of the peritoneum to irritation or infection depicts for us the formation of a subserous edema; a choking of the vessels with leucocytes; margination and migration of the white cells through the vessel walls into the surrounding tissues; the escape of varying numbers of red cells with the leucocytes and the delivery of the subserous edema, at least in part, into the peritoneal cavity where it assists in the formation of a plastic exudate and provides a medium for the activity of the phagocytes, opsonins and other anti-bodies, lytic ferments, etc. Following the successful conclusion of the defense reaction we have the terminal defense-repair effort, resolution. This activity is marked by the return of neutrophilic leucocytes to the vessels; a tremendous increase in the number of large wandering cells; recession of the subserous edema, and a restoration of surface continuity. In our attempt to activate the peritoneal defense mechanism by the use of amniotic fluid concentrate, we have succeeded in reproducing this picture.

Taking a section of normal peritoneum (Figs. 9 and 10) as a standard and comparing it with a section of peritoneum from a dog that had been injected intraperitoneally with 50 cubic centimeters of amniotic fluid concentrate 12 hours previously (Fig. 11), we find that definite changes of a defensive nature have taken place. Most impressive is the tremendous edema of the subserous tissues. The lymphatics in the loose areolar tissue are notably dilated and the blood vessels show typical margination and migration of the leucocytes (Fig. 12). The veins, especially, are distended in keeping with the normal physiology of defense. The mesothelial layer is intact and, from its relation to the subserous edema, it is not difficult to visualize this structure acting as a filter through which the defense edema is delivered into the peritoneal cavity where it forms the exudate common to peritoneal response to infection. Figures 13 and 14 show the next step in the defense mechanism when infection enters the field. The dog from which this section was taken received a virulent cul-

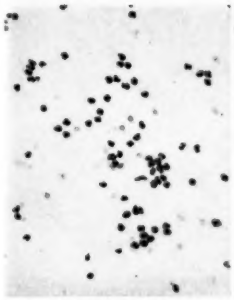

Fig. 1.

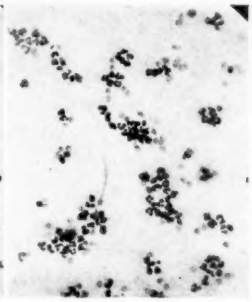

Fig. 2.

Fig. 1. Smear of visceral peritoneum: reaction to amfetin at 12 hours. ×110.

Fig. 2. Smear of visceral peritoneum: reaction to colon vaccine at 72 hours. ×110.

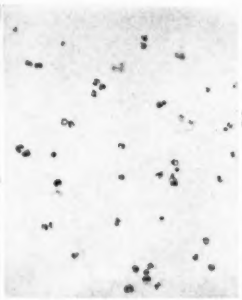

Fig. 3.

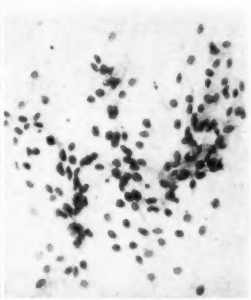

Fig. 4.

Fig. 3. Smear of visceral peritoneum: reaction to normal saline at 12 hours. ×110.

Fig. 4. Smear of normal visceral peritoneum of young healthy dog. ×110.

ture of Streptococcus hæmolyticus at the same time that amniotic fluid concentrate was introduced. The dog survived the infection and was sacrificed at 48 hours to obtain specimens. Most striking in the low power study of this picture (Fig. 13) is the tremendous number of leucocytes present in the subserous tissue. The subserous edema, noted in uninfected animals, has been largely delivered into the peritoneal cavity. Here the defense elements contained in this edema, such as opsonins and other anti-bodies, lytic ferments, fibrin, certain catalytic agents, etc. join in the general defense repair effort. A section of fibrinous exudate (Fig. 14) seen on the peritoneal surface of this animal is very instructive since it suggests the probable order of defense and resolution. A mass of fibrin, literally loaded with leucocytes and a small number of histocytes, is seen as it is being lifted off the mesothelial cells by a layer of huge histocytes. This picture is typical of the normal order of defense and repair and in the presence of such a vigorous defense reaction, it is not difficult to understand why we find less remote postoperative adhesions in some cases suffering from a severe primary infection than in cases of peritoneal surgery in which infection has not

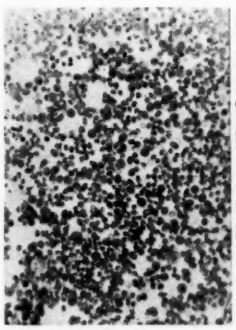

Fig. 5.

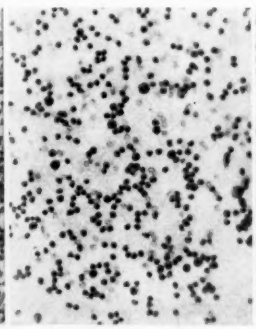

Fig. 6.

Fig. 5. Smear of peritoneal exudate from control animal: 60 hours after infection with colon bacillus and Streptococcus hæmolyticus. ×120.

Fig. 6. Smear of visceral peritoneum: 48 hours after injection of excessive dose of colon vaccine (4 billion per cubic centimeter) in normal saline. ×120.

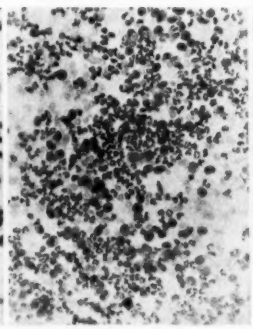

Fig. 7.

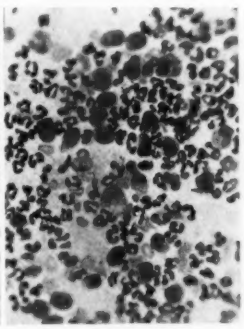

Fig. 8.

Fig. 7. Smear of visceral peritoneum: 60 hours after infection with Streptococcus hæmolyticus and colon bacillus in dog protected by amniotic fluid concentrate. Immunization interval 12 hours. ×120.

Fig. 8. (Same as Fig. 7.) Oil immersion. Smear taken from dog making excellent clinical recovery. Note the apparent activity of the histocytes in this stage of resolution. ×250.

Fig. 9, left. Normal peritoneum—low power. ×30.
Fig. 10. Normal peritoneum—high power. ×135.

played a part. Attention is also called to the fact that in this entire defense response, under stimulation by amniotic fluid concentrate, hemorrhage is not conspicuous.

The intraperitoneal introduction of irritating chemicals, foreign bodies, bacterial vaccines, or any combination of the foregoing, causes a considerable variation in this defense picture. Hemorrhage is present in proportion to the amount of irritation or trauma. The volume of exudate or transudate is influenced markedly by the type and tonicity of the irritating substance and the exudate cell picture at the end of 24 to 72 hours may be so altered as to be almost a complete reversal of the classical order of the defense mechanism.

Fig. 11, left. Peritoneal reaction to stimulation by amniotic fluid concentrate at 12 hours. ×48.
Fig. 12. Oil immersion of Figure 11 to show leucocytic margination and migration. ×250.

Specific instances of the distortion of the peritoneal defense mechanism may be seen in the use of substances such as papain, sodium ricinoleate, hypertonic glucose, various oils, and the bacterial vaccines, especially if the latter be suspended in a gum tragacanth solution.

Considering first the peritoneal response to the introduction of bacterial vaccines (Fig. 17) we see at the end of 24 hours a marked cellular infiltration of the subserous tissues with the formation of a considerable amount of surface exudate. There is also present a moderate amount of subserous edema. A closer study of the field under high power and oil immersion (Figs. 18 and 19) brings out the fact that the cellular infiltration is almost entirely histocytic. The exudate appears to be

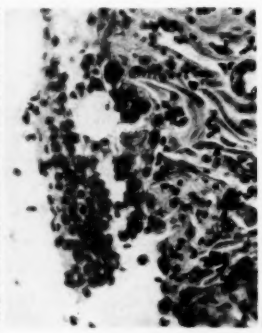

Fig. 13. Fig. 14.

Fig. 13. Peritoneal reaction to Streptococcus hæmolyticus introduced at the same time as the amniotic fluid concentrate. ×50.
Fig. 14. Oil immersion of Figure 13 to show phagocytic activity present in the vicinity of the fibrinous exudate.

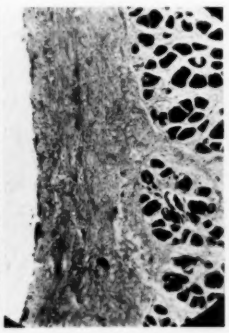

Fig. 15. Fig. 16.

Fig. 15. Section of peritoneum from control animal following infection. ×50.
Fig. 16. Same as Figure 15, oil immersion. ×267.

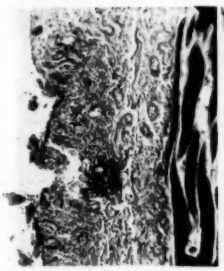

Fig. 17.

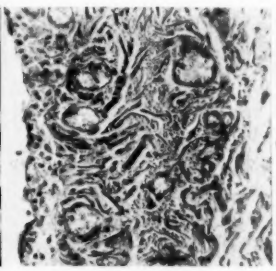

Fig. 18.

Fig. 17. Peritoneal response to colon vaccine in gum tragacanth at 24 hours. ×47.

Fig. 18. Enlargement of Figure 17, to show subendothelial infiltration of histocytes. ×135.

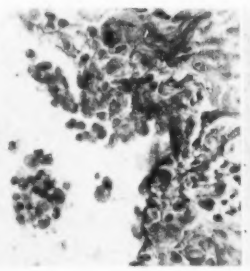

Fig. 19.

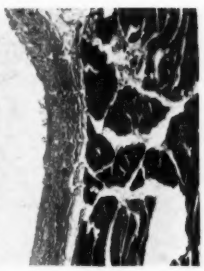

Fig. 20.

Fig. 19. Oil immersion of Figure 17 to show cellular structure of exudate. ×250.

Fig. 20. Peritoneal reaction to normal saline at 12 hours —introduced for comparison. ×23.

made up completely of these large wandering cells enmeshed in a few loose strands of fibrin. Not only does the serous surface appear well supplied with histocytes but the immediate subserous connective tissue is literally choked with them and the infiltration even extends into the muscle layer. Consistent with this cell picture is the fact that the blood vessels in this same section fail to reveal the presence of the typical defense picture of leucocytic margination and migration.

The peritoneal reaction to infection at 48 hours after the introduction of a 24 hour living culture of colon bacillus on an agar slant may be seen in Figures 21 and 22. This animal had received the full 72 hour immunization interval recommended in the use of colon vaccine. The subserous connective tissue shows no evidence of edema and contains areas of hemorrhage. The exudate is made up almost entirely of histocytes and abundant cell detritus. In view of the fact that the defense exudate in animals treated with colon vaccine is usually hemorrhagic in appearance, the presence of subserous hemorrhage and a large amount of cell detritus in the surface exudate is significant. This seems to indicate that the color of the peritoneal exudate in these animals is due to broken down red cells.

The overwhelming number of histocytes in

Fig. 21.

Fig. 22.

Fig. 21. Low power study of peritoneal response to 24 hour agar slant of colon bacillus. Dog protected by 72 hour immunization interval with colon vaccine. ×54.

Fig. 22. Same as Figure 21—oil immersion. Magnification to show hemorrhagic exudate and predominance of histocytes. ×280.

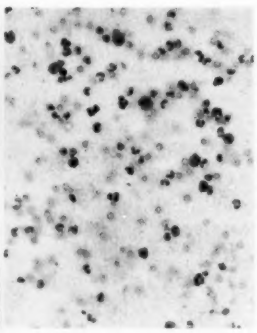

Fig. 23.

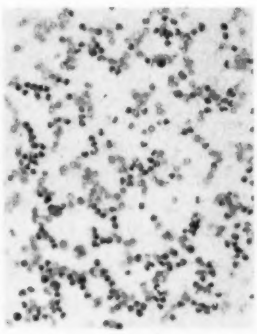

Fig. 24.

Fig. 23. Smear of visceral peritoneum from dog protected by colon vaccine—72 hours immunization interval —sacrificed at 48 hours after infection with colon bacillus. ×133.

Fig. 24. Smear of visceral peritoneum protected by amniotic fluid concentrate—12 hour immunization interval—sacrificed at 48 hours following infection with colon bacillus. ×133.

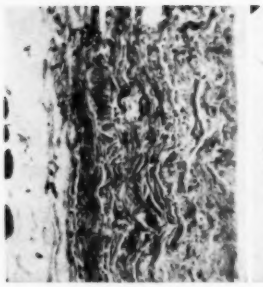

Fig. 25.

Fig. 26.

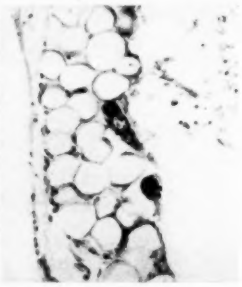

Fig. 27.

Fig. 28.

Fig. 25. Peritoneal response to the introduction of papain (1:200,000 dilution) to show digestion of mesothelial layer and contiguous, subserous connective tissue. ×235.

Fig. 26. Effect of sodium ricinoleate (1 per cent solution) on peritoneum. ×22.

Fig. 27. Same as Figure 26—increased magnification to show disruption of cell structures. ×106.

Fig. 28. Smear of exudate at 12 hours from animal injected with sodium ricinoleate to show disruption of cell membranes of histocytes and low white cell count. ×110.

the exudate of the infected and non-infected colon vaccine animals may be explained by the presence of the dead bacteria of the vaccine and the excess of cell detritus in the exudate. This view is in keeping with the established function of the histocyte as a scavenger and may be some indication of the destructive effect of a given agent.

Papain digests fibrin and the mesothelial layer of cells (Fig. 25). To this extent, localization of infection and the prevention or retardation of absorption of bacteria and their toxins is interfered with. Sodium ricinoleate in a 1 per cent solution is extremely irritating (Figs. 26 and 27). It sets up a violent reaction in the peritoneal cavity with the formation of a tremendous transudate of low cell count (Fig. 28). There is also present a widespread disruption of surface tissue cells and phagocytes. Hypertonic glucose solution (20 to 50 per cent) while not destructive like sodium ricinoleate, does induce the formation of a large transudate and consequently interferes with localization of infection resulting in a high mortality among the experimental animals (2). The oils are notorious for their ineffectiveness in preventing adhesions and for the formation of so called oil tumors.

RESULTS OF STUDY

The purpose of this investigation has been to weigh the merits of substances commonly introduced into the peritoneal cavity to establish peritoneal immunity or prevent adhesions, or both. Our chief concern is to secure the highest possible degree of protection against postoperative infection and adhesions with a minimum of physiological disturbance. In accomplishing this point an important factor is the time required in obtaining the optimum defense reaction to a given stimulating agent, the so called immunizing interval. Equally important is the systemic effect upon the patient. Guided by previous teachings and our own experimental work we have tried to reproduce, aseptically, the classical peritoneal reaction to infection.

We believe that the ideal activator of peritoneal immunity is a substance which chemical analysis and extensive clinical and laboratory trial has proved innocuous; one which may be used before operation without discomfort or clinical upset; one which has an immunizing interval sufficiently brief to be adaptable to operative introduction; one which is vigorous enough to be effective without overstepping the stimulation threshold; and, finally, one which will induce a peritoneal reaction similar in character to that laid down by the normal peritoneum in the presence of infection. In addition to these requirements such an agent should be stable and free from remote, untoward reactions.

From the experimental and clinical evidence upon which this paper is based it has been definitely proved that amniotic fluid concen-

trate most effectively meets the foregoing requirements. The only other substance now being employed to any extent as an activator of peritoneal immunity is the bacterial vaccine of Rankin and Bargen with modifications by Steinberg and Goldblatt. Extensive clinical trial and laboratory experiments have proved this agent effective. However, its use is confined to pre-operative administration, 48 to 72 hours before the abdomen is opened, and the protection afforded by its introduction is attained at the cost of a considerable physiological and clinical upset and a long immunizing interval. In our experimental work, at least, the product itself has not proved stable.

Other substances, such as normal saline, papain, and sodium ricinoleate were studied chiefly as controls and for the purpose of learning their beneficial or destructive qualities in the infected and uninfected animals.

A careful study of the charts, grafts, smears, and tissue sections submitted will substantiate the foregoing observations.

SUMMARY

1. Evidence deduced from a study of 70 dogs shows that certain substances when introduced into the peritoneal cavity will excite the production of a defense exudate.

2. The character of the exudate will depend upon the substances introduced.

3. The use of agents relying upon digestive ferments or excessive irritation interferes with the normal physiology of defense and repair.

4. The brief immunization interval required in the use of amniotic fluid concentrate makes it adaptable for operative as well as pre-operative introduction.

5. Amniotic fluid concentrate proved to be the most effective agent used in these experiments.

6. This study is aimed to contribute to the knowledge of the basic principles of peritoneal immunization and is offered as an aid and stimulus to further investigation in this comparatively new and important field.

Grateful acknowledgement is made to Dr. Elliot C. Cutler, professor of surgery, Harvard Medical School, for his generous co-operation throughout this experimental work, and to Dr. Robert N. Nye, of the Department of Pathology, Boston City Hospital, for his advice and technical assistance in the preparation of cultures.

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CLINICAL SURGERY

FROM THE MAYO CLINIC

THE REPAIR OF POSTOPERATIVE DEFECTS INVOLVING THE LIPS AND CHEEKS SECONDARY TO THE REMOVAL OF MALIGNANT TUMORS

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THE majority of defects about the mouth, which come under the care of the plastic surgeon, are congenital or traumatic, or are the result of treatment of malignant tumors. While perforation of the lips, cheeks, or jaws rarely develops following proper treatment in the early stages of malignant neoplasms of these structures, the thorough removal of extensive carcinomas in these situations not infrequently results in such defects, regardless of whether eradication is effected by surgical measures, irradiation, or escharotics. The use of escharotics probably accounts for a proportionately higher percentage of perforations than does surgical treatment or radiation, since the destructive process is less readily controlled. It is chiefly with the postoperative group of defects and their repair that we shall deal in this discussion.

The occurrence of perforation following the operative removal of a malignant neoplasm about the mouth is at times interpreted as reflecting adversely on the skill and judgment of the surgeon. In the majority of instances, such interpretation is entirely unjustifiable. As a matter of fact, it frequently indicates a wider knowledge and greater experience in dealing with lesions of this type than is evinced by patients who reveal only slight loss of tissue. In treating localized inactive malignant lesions in this situation, an element of conservatism is justifiable, but extensive active growths must be removed widely, regardless of the deformity produced. This frequently will necessitate sacrificing a large portion of the upper or lower lip, or both, and at times, a portion of the cheeks, jaws, and floor of the mouth as well. Moreover, in most cases of this type it is highly inadvisable to carry out reconstructive procedures until after the patient has been free of evidence of the disease for a considerable time. A good deal of courage and conviction on the part of the physician is required to convince the patient of the necessity of producing such a defect and delaying its closure. Not only is the patient likely to seek treatment elsewhere, but on account of the scarring, greater difficulty often is encountered in carrying out repair at a later stage than would have been met in doing an immediate closure. Primary closure of wounds, following the removal of advanced malignant lesions, even in cases in which there is attachment to the bone, is still practiced by some surgeons. More often than otherwise, however, such efforts lead only to disappointment as recurrence promptly ensues in a high percentage of these cases. At times, the extensive sacrifice of tissue renders immediate repair a physical impossibility. In other instances, the general condition of the patient is not sufficiently satisfactory to permit the operation to be prolonged.

The opportune time for repair of defects about the mouth, which result from the removal of malignant tumors, varies with the nature, activity, previous treatment, situation, and extent of the lesion, and with the age and general condition of the patient. Generally speaking, reconstruction should be delayed somewhat longer following treatment of a squamous cell epithelioma than after treatment of a basal cell growth, and longer after the removal of a highly malignant lesion than after the removal of an inactive one. A tumor that has been treated previously, especially with irradiation, or one that has been cleared up with irradiation, may recur much later than one that has not been treated previously or that has been removed surgically. This is because malignant cells may lie dormant in the dense scar for a longer time. Lesions involving bone secondarily may gradually extend along the periosteum

Fig. 1a.

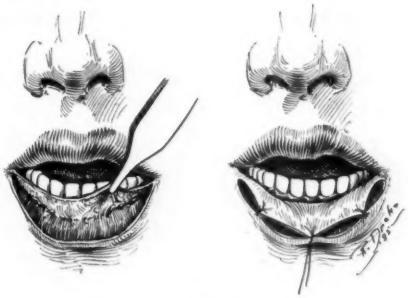

Fig. 1b.

Fig. 1. Method of removing the mucous membrane of the entire lower lip for precancerous lesions such as thickened patches of leucoplacia, patches of keratosis, or other lesions which undergo early malignant changes. Figure 1a shows the incision and a portion of the mucous membrane and subcutaneous tissue which has been elevated; in Figure 1b, the mucous membrane from the inside of the lower lip has been freed, rolled out, and sutured to the skin.

Fig. 2. Completion of suturing of the mucous membrane from the inside of the lower lip to the skin.

Fig. 2.

and recurrence become manifest much later than in the cases in which tumors affect only the soft tissues. There is greater likelihood of recurrence after removal of extensive growths than there is after removal of localized tumors. Malignant neoplasms that affect young individuals usually are more active and more prone to metastasize than are those which affect older people; repair, therefore, should be delayed longer in the former group than in the latter group. It need scarcely be mentioned that a patient in poor general condition should not be subjected to extensive plastic repair, even though the lesion apparently has been eradicated completely. Reconstruction should be delayed until the condition of the patient improves. At times, the removal of a large, foul, malignant lesion of the lips or cheeks is advisable, even in the presence of inoperable metastasis, because of its deleterious effect on the general health of the patient and in consideration of those who must associate with him. If the loss of tissue in such cases is too great to permit primary closure of the defect, delayed reconstruction rarely is to be considered.

Most recurrences following the removal of malignant neoplasms take place within 6 months to a year. Accordingly, in the cases in which elderly individuals have had tumors, which have revealed a low grade of malignancy, repair is justifiable after the patient has been well for 6 or 8 months, while with more active and extensive growths, especially in cases in which the patients are young, reconstruction is better delayed for at least a year. By this time, devitalized bone will have separated, the inflammatory reaction will have subsided, and the margins of the perforation will have healed. If local recurrence or metastasis is to occur, it usually, though not always, will have become evident within this period. In several instances we have seen local recurrence develop more than a year after removal of a carcinoma of the lower lip and in one case both local recurrence and pulmonary metastasis became demonstrable almost a year and a half after removal of a lymphosarcoma of the cheek of an elderly individual. In another case metastasis to the submental lymph nodes developed 16 years after permanent local cure of an epithelioma of the lower lip.

Recurrence of a malignant growth, which develops after repair is well under way or completed, presents a serious problem. Such a recurrence, which occurs beneath the graft, cannot, as a rule, be recognized until well advanced and it then necessitates sacrifice of not only the transplanted tissues but of much adjacent tissue as well. Indeed, in such an event, it will be fortunate if the

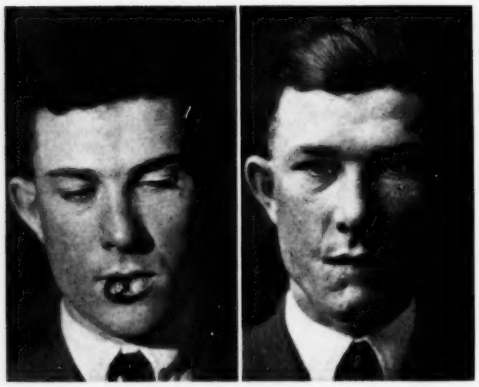

Fig. 3. Epithelioma of the lower lip; before and after excision of the epithelioma.

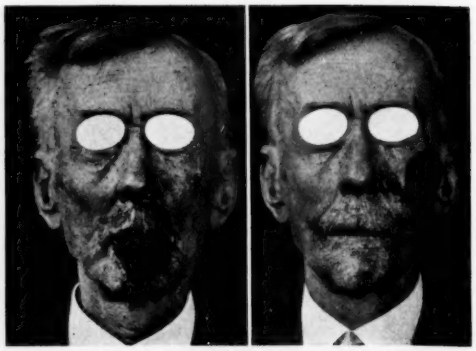

Fig. 5. Extensive epithelioma of the entire lower lip and chin, and two epitheliomas of the left cheek. At right, the reconstructed lower lip is shown. The epithelioma of the lip has been removed with surgical diathermy.

Fig. 4.

Fig. 6.

Fig. 4. Lines of incision for excision of epithelioma of lower lip and for plastic reconstruction of angle of mouth, in order to enlarge the lip. The details of this operation are shown in Figures 7, 8, and 9. In certain cases the shaving of a portion of the mucous membrane of the lip, as in Figure 1, is combined with this operation.

Fig. 6. Lines of incision for removal of the growth. The details of this operation are shown in Figures 7, 8, and 9.

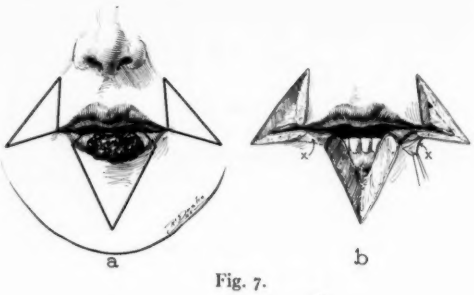

Fig. 7.

Fig. 7, a. The lines of incision may be noted. The triangular portion removed from the upper lip and cheek does not extend through the mucous membrane into the mouth; b, the small triangular area of skin, *x*, just anterior to the mucous membrane is excised in order to allow the freed up mucous membrane to approximate the skin, forming a new vermilion margin. (As far as we can make out, the technique of this operation, with the exception of a few modifications, was first used by C. H. Mayo.)

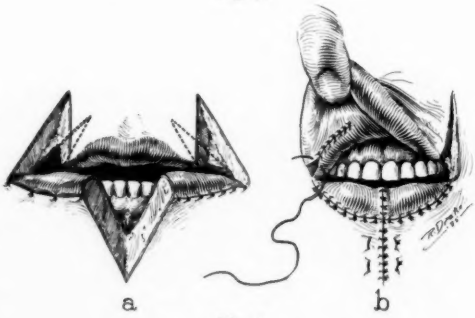

Fig. 8.

Fig. 8, a. The dotted triangular area is excised from the mucous membrane of the inside of the upper lip on either side in order to roll in the angles of the mouth so that the vermilion margin gradually disappears at the angles; b, closure of the mucous membrane inside the upper lip with interrupted catgut to roll in the angles of the mouth.

condition has not progressed to an inoperable stage.

The problem of repair following the removal of malignant lesions about the mouth varies greatly in different cases, depending on their situation, extent, and degree of malignancy. Precancerous conditions, such as thickened patches of leucoplacia and keratosis, in this situation are best

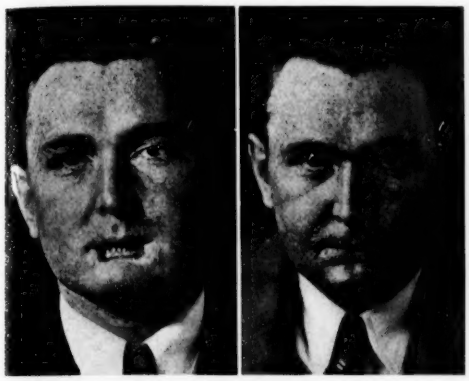

Fig. 10. Secondary closure following removal of the epithelioma of the lower lip. This is suitable for cases in which the growths are of an active type and require cautery excision and treatment with diathermy, rather than primary plastic operation. Loss of the greater part of the lower lip can be noted in left figure; as shown in right figure, the lower lip has been reconstructed with the technique illustrated in Figures 7, 8, and 9.

Fig. 11. Loss of greater part of the lower lip, chin, and angle of mouth, secondary to removal of extensive active epithelioma of the lip and chin. At right is shown the result of the operation. The replaced portion of the lower lip may be noted.

removed by superficial excision or "shaving." This consists in excising sharply an elliptical piece of mucous membrane and submucous tissue of the lip. The piece, which is excised, should extend along the vermilion border of the lip and beyond the pathological tissue. The posterior margin of the wound is then undercut, and the mucous membrane inside the lip is drawn out and sutured to the cutaneous anterior edge, thereby furnishing a new vermilion border for the lip. If the growth appears malignant clinically, it is excised by removing a wedge from the lip, and the wound is closed primarily. A high percentage of carcinomas, which originate on the lower lip, have a low grade of malignancy or are moderately active, and even though rather extensive, immediate closure of the wound is permissible following their removal. Immediate reconstruction can readily be carried out, even when it has been necessary to sacrifice the entire lower lip. A number of different surgical procedures have been devised for

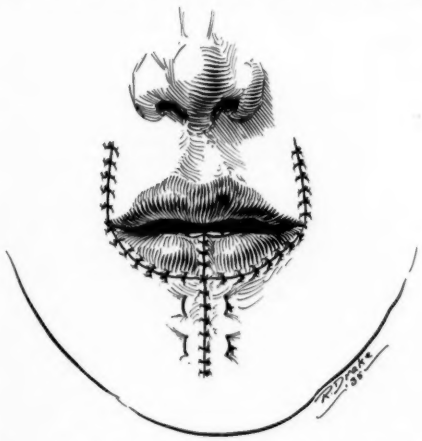

Fig. 9. Completion of the reconstruction of the lower lip.

Fig. 12. A flap, which has the pedicle along the vermilion margin (Estlander's operation), is elevated from the left half of the upper lip and rotated down into position along the lip, after the scarred margins have been excised. As a secondary procedure, after the wounds have healed, the mouth is enlarged to the left by an incision into the angle, and by rolling out the mucous membrane. The scars which extend from the angle of the lip respectively to the ala and to the chin usually make one continuous perpendicular line.

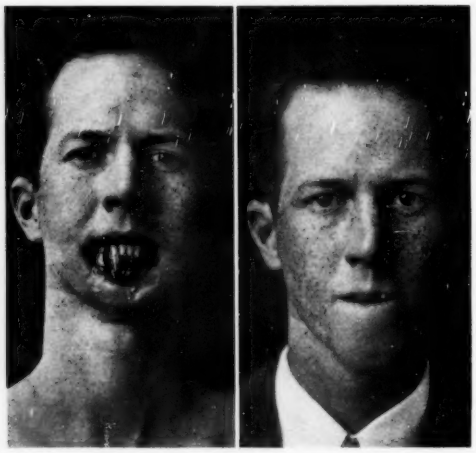

Fig. 13. Loss of entire lower lip and a portion of the chin, secondary to removal of an active epithelioma with cautery and diathermy. Views before and after reconstruction of lower lip.

this purpose. One of the simplest and most satisfactory of these, both as regards removal of the malignant process and the appearance and function of the reconstructed lip, is excision of the growth with a wide V. Following primary closure of this defect, an incision should be made laterally into the cheeks, through the angle of the mouth on either side, and an inverted wedge should be removed from the inner portion of the cheeks. By reversing the procedure, the upper lip may be reconstructed in the same manner. This is somewhat more difficult than the last procedure and the cosmetic result is less satisfactory, because of the fixation of the tissues about the nose and the greater prominence of the scarring, which results from removal of a wedge from either side of the lower lip. Delayed closure in such cases is, as a rule, necessary only in cases in which the growth involves the mandible or superior maxilla secondarily, or when it is highly malignant.

While immediate repair is desirable in these cases, it should never be carried out unless the lesion can be removed together with an adequate margin of normal tissue. This is practically im-

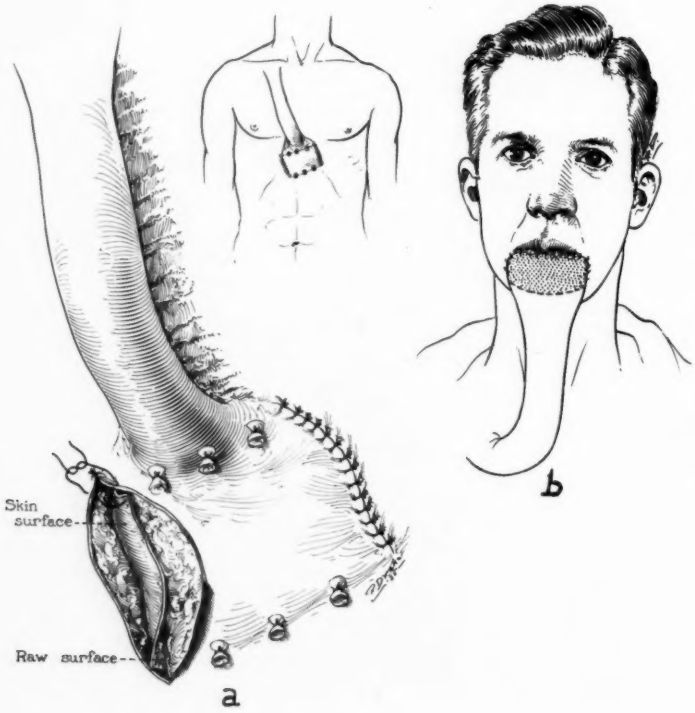

Fig. 14, a. The flap is tubed on the right side of the thorax and at a second procedure the lower portion of the flap is extended and lined with a full thickness skin graft, which will later form the lining of the lower lip. The flap, however, should not cross the midline as it does in the drawing. The sutures tied over gauze above and below the outlined area hold the margins of the skin graft in position; b, the lined flap has been brought up and sutured in place to reconstruct the lower lip. The dotted area outlines the full thickness skin graft on the under surface.

Fig. 15. Loss of part of lower lip, angle of the mouth, and cheek. Before and after reconstruction of lower lip and closure of the cheek.

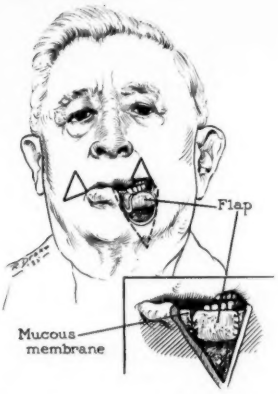

Fig. 16. A flap is turned up to form the lining of the lip and sutured on either side to the mucous membrane of the lip and cheek. After excising the triangles at either angle of the mouth, the skin is freed from the lip and cheek and brought together over the lining. The excision of the angles of the mouth is detailed in Figures 7, 8, and 9.

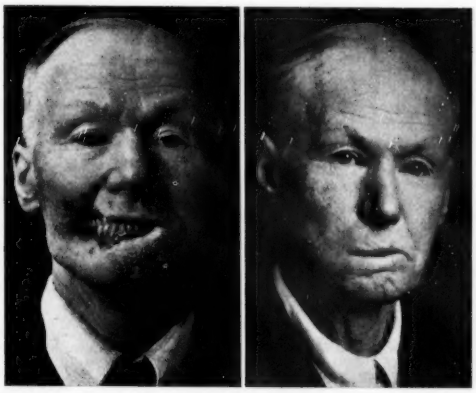

Fig. 17. Loss of the greater part of lower lip, cheek and angle of the mouth, with fixation of the tissues to the jaw by the scar. Photographs taken before and after replacement of tissues of upper and lower lip and cheek. The scarring along the lower border of the flap forming the lower lip is still to be smoothed out.

Fig. 18. Tubed flap has been elevated and the lower end lined as illustrated in Figure 14, a. It is then brought up and sutured in place to replace the lower lip and angle of the mouth. The dotted area shows the extent of the full thickness skin graft lining.

possible in cases in which the carcinoma has invaded the bone. There is a definite tendency when primary closure of the wound is anticipated, to excise a narrower margin of normal tissue than is consistent with safety, and the likelihood of recurrence is accordingly increased. The prognosis following subsequent excision is naturally less satisfactory than it is in cases in which the primary excision has been wide, and the wound must necessarily be left open so that it is far preferable that closure of the original wound be delayed. It is our practice, in cases in which wounds about the mouth are to be sutured primarily, to excise the tumor with the scalpel while in cases in which secondary closure is planned, we employ cautery excision or electrocoagulation.

For some years, malignant tumors of the jaws and of the soft tissues inside the mouth have been treated in the clinic with electrocoagulation. Frequently, this therapy is supplemented with the implantation of radium. The wounds granulate promptly following separation of the slough and there is no interference with function, aside from slight restriction of movement of the mandible, which is the result of loss of the mucous membrane of the inside of the cheek. The degree of limita-

Fig. 19. Perforation of the angle of the mouth and cheek, with scarring of the upper and lower jaws, causing ankylosis secondary to removal of an epithelioma of the cheek with surgical diathermy. The tubed flap on the chest may be noted, and at right, photograph of patient after closure of the perforation and correction of the ankylosis of the jaw.

tion of movement varies greatly, depending on the extent and situation of the scarring. At times, complete ankylosis results and restoration of the lost lining is necessary for relief. This is accomplished by freeing the scarred attachment to the mandible and restoring the buccal folds by relining this portion of the mouth with shaved skin grafts applied over dental compound. In cases in which these lesions inside the mouth extend deeply into the soft tissues so that they lie directly beneath the skin, or are attached to it, it frequently is impossible to remove them completely, either with diathermy or the cutting cautery, without perforating the cutaneous surface. In this event, provided there is not extensive involvement inside the cheek and the lesion has a low grade of malignancy, it may be possible to close the wound primarily. More often, however, secondary closure will be advisable.

Defects that involve the angles of the mouth, the lips, and the cheeks often can be taken care of either primarily or secondarily in a single stage, with tissues from the immediate vicinity. Even though the lesion has not extended deeply enough to necessitate sacrifice of the full thickness of the lip or cheek, ectropion of the lip will frequently result. This can, as a rule, be corrected by dissecting away the scar tissue and either applying a Wolfe graft or turning in a flap from the adjacent region to cover the denuded surface. At times, when only a small perforation of the cheek is present, this can be repaired by utilizing a hinged flap from near the margin for a lining, and covering this with a full thickness skin graft.

In most cases, extensive loss will necessitate bringing in tissue from a distance for reconstruction. For this purpose, pedicled flaps may be secured from the forehead, neck, arm, thorax, back, or abdomen. The most favorable sites are the forehead and the thorax. While the color, vascularity, and texture of the tissues of the forehead render these highly desirable for the repair of such facial defects, their use results in additional scarring on an exposed portion of the body. If the patient is a woman, this will be, as a rule, less of a disadvantage than it will be if the patient is a man, since the skin graft used to cover the region from which the flap is taken can be very

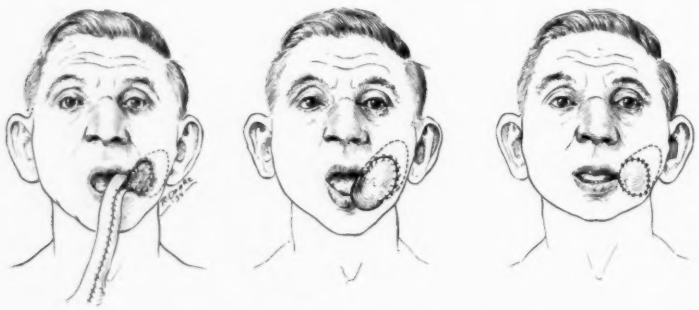

Fig. 20. The first drawing shows the distal end of the tubed thoracic flap which has been elevated, opened, and carried back into the commissure between the upper and lower jaws, after the scarring has been excised to allow the patient to open the mouth. The second drawing shows the tube cut across, opened up, and used as a covering for the perforation, which has been lined by the distal end of the flap. The third drawing shows the completion of the plastic procedure after excision of the intervening part of the tubed flap and closure of the angle of the mouth.

Fig. 21. Photographs showing loss of entire upper lip and columella of the nose, following removal of an epithelioma; and after the upper lip has been reconstructed.

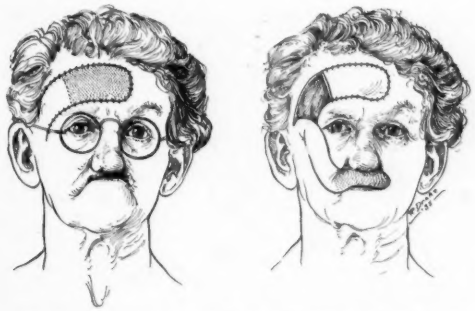

Fig. 22. A delayed flap with a pedicle in the right temporal region was elevated, and the distal end of the pedicled flap, which is outlined by the dotted area, was lined with a full thickness skin graft. After delay, this is brought down to reconstruct the upper lip. The skin graft forms a lining for the upper lip.

effectively covered with the hair. If the patient has a thin skin, the scarring about the graft on the forehead becomes so inconspicuous that at times it can scarcely be noticed. If the skin of the patient is thick, on the other hand, both the graft and the scar about its border may remain unduly conspicuous. For this reason, flaps from the thorax or back are, as a rule, employed at the present time in the majority of cases in spite of the fact that they require considerably more time and involve greater expense to the patient because of longer hospitalization than does a flap from the forehead. Whereas a flap from the forehead can be transferred and the reconstruction completed in the course of approximately 2 months, a flap from the anterior or posterior aspect of the thorax will require a much longer time. Such a flap from the thorax must be tubed, which usually causes a delay of at least 3 months before transference, while a flap from the forehead is ready to be moved in approximately 2½ to 3 weeks. In addition to furnishing a new skin surface, and at times, a lining as well, flaps from the thorax frequently are utilized for supplying subcutaneous adipose tissue to an area about the face. Restoration of the symmetry of the two sides of the face, especially of the cheeks, is thereby possible. Such a flap would, of course, not be required unless it were necessary to replace the skin as well as to supply subcutaneous fatty tissue, for otherwise, a free fat transplant would be resorted to.

A lining for the reconstructed lip or cheek in these cases is furnished by grafting skin on the under surface of the distal portion of the flap. Full thickness grafts are most satisfactory for this purpose. The graft must be applied a sufficiently long time prior to transference of the flap to permit it to become attached firmly. Flaps from the thorax must be of sufficient length to reach without tension from the point of attachment of the pedicle, which usually is situated just over or below the clavicle anteriorly or over the base of the trapezius muscle posteriorly, to the defect on the face. The length of the flaps that are obtained from the region of the clavicle or from the region of the trapezius muscle is greater than the length of the flaps that are obtained from the forehead. The tissues in the region of the clavicle or in the

Fig. 23. Actinodermatitis of the right cheek, secondary to treatment of an angioma with radiation. Three of the patches on the cheek revealed epithelioma. The entire lesion was excised and replaced with a free full thickness skin graft from the inside of the arm. It will be noted from the figure at right that the entire graft has taken.

Fig. 24. Deformity of right cheek with loss of a portion of the malar bone and zygoma, and part of the lower jaw, following removal of a squamous cell epithelioma, grade 3, with surgical diathermy. The deformity was corrected 5 years later with a tubed flap from the back, the fat in the tube being utilized to build out the cheek. Photograph at right shows that the distortion and displacement of the ear have been corrected and the normal fullness of the cheek has been restored. Further improvement could be made by forming a nasolabial fold.

region of the trapezius muscle are comparatively avascular. These facts explain why it requires more time to secure flaps from the latter situations than it does to secure flaps from the forehead. The color and texture of grafts from the latter regions also correspond much less satisfactorily to the tissues of the face than do the color and texture of grafts which have been obtained from the forehead, but these differences become less pronounced in the course of time. At times, it is of advantage to transfer the lower attachment of the chest flap to the mastoid or cervical region, and then to utilize the clavicular end of the flap for the repair. This may be desirable because of the thin skin in the clavicular area, or it may be necessary because the flap was not long enough.

Repair of extensive loss of tissue about the mouth can be carried out very satisfactorily in many cases with local infiltration anesthesia only, and at times, it is of advantage to do so. This is generally true in cases in which the patients are elderly individuals. As a rule, however, it is preferable to execute the more time-consuming and painful stages of the procedure under general anesthesia, and to use local anesthesia for the minor steps and those in which the distortion incident to infiltration with novocaine will not constitute a serious disadvantage. According to this scheme, the original elevation and grafting of a flap from the forehead, and its transference, as

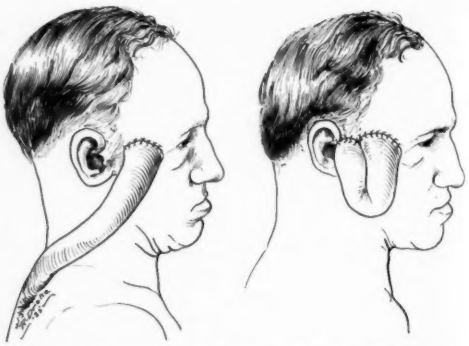

Fig. 25. The distal end of the tube was carried to the upper portion of the scarred area. The upper end of the tube was carried anterior to this in the temporal region and the tube was then smoothed out to replace the lost tissue of the cheek.

a rule, are carried out under general anesthesia. In cases in which a flap from the trunk is utilized, the primary stage in which the flap is tubed is performed with general anesthesia. Intratracheal anesthesia with the tube inserted through the nostril also is extremely satisfactory for this purpose, particularly at the time the flap is transferred, since it permits a clean field to be maintained, the anesthetist is well back out of the way, and the anesthetic is well controlled. In addition, the pharynx can be tightly packed off to eliminate the hazard of blood entering the air passages.

The improvement in the general health of the patient, which follows repair of long standing operative defects of the lips and cheeks, often is marked and manifested promptly. While in many instances there is little evidence that the perforation into the mouth produces a detrimental effect on the general health of the patient, some of these individuals become markedly dehydrated and anemic, and have difficulty with elimination. This apparently is the result of loss of fluid in the saliva, which drools through the operative opening, and the lessened fluid and caloric intake, which are occasioned by increased difficulty in eating and drinking. After correction of these conditions, following closure of the opening, the general health of the patient often improves decidedly and there is considerable gain in weight. An equally important feature in this regard is the notable change in the mental attitude which is incident to the discarding of the dressing that has been worn on the face for a number of months.

No originality is claimed for any of the operative procedures employed. Many are very old and some bear the names of their advocates.

CONDITIONS NECESSITATING SURGERY FOLLOWING CHOLECYSTECTOMY[1]

An Analysis of Sixty-six Cases and a Discussion of Certain Technical Problems Concerned in Removal of the Gall Bladder and in Operations upon the Common Bile Duct

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FOLLOWING removal of the gall bladder, conditions demanding further surgical therapy may develop during the period of postoperative recovery, or later as a complication of, or sequel to, the biliary tract disease, or because of mishaps incident to the procedure itself.

This survey is an analysis of 66 cases reoperated upon in the University Hospital, over a period of 15 years, following cholecystectomy. Inasmuch as patients sent to this hospital are committed from all of the counties of the state of Iowa, it would seem that this survey fairly represents the experience of the medical profession of the commonwealth, together with that of the Surgical Service of the University Hospital.

All patients who have had cholecystectomy performed in this hospital or elsewhere are included in this series if they have required subsequent surgical attack. In some of the patients, attack was made, at the time of original operation, upon the common duct in addition to cholecystectomy. In a large majority the appendix was removed. An analysis of the 66 cases comprising this survey shows that they fall rather definitely into 6 well defined groups. In addition to these groups, there are a few cases of miscellaneous character.

A. "Reformed gall bladder"—14 cases. The term "reformed gall bladder" is used, as it seems to express a clinical situation in respect to symptomatology even if it is a misnomer pathologically. On the basis of the findings it seems reasonable to explain the development of a pouch simulating a gall bladder as due to the dilatation of a cystic duct stump. The pouch commonly varied from 1 to 2.5 inches in length and was usually of the caliber of one's little finger. It was often clubbed in shape. In the occasional case, the pouch was of such size and configuration as to suggest that division had been made across the gall-bladder wall at the time of cholecystectomy.

The pathology was characterized in every instance by extensive adhesions which hid the hilus of the liver, the common duct, and the "new" gall bladder. Upon exposure of the major ducts by dissection, the "reformed gall bladder" was found "frozen" to the hepatic duct in 4 cases, and to the common duct in 2. In such instances a ready explanation for the patient's symptoms was at hand. In 5 there was angulation of varying degree of the major ducts and usually at the junction of the common hepatic with the common. In some, this distortion was so marked that obstruction in considerable degree was produced. In 4 patients the "gall bladder" contained calculi.

Associated pathological change was not as commonly found as might be expected. In only three instances was there present a stone in the common duct, and in one of these there was marked cholangectasis. In another there was a marked inflammation of the common duct beyond that of the neighborhood inflammation from the adherent "new" gall bladder. In 1 patient a fistula was present between the gall bladder and duodenum, and in this tract were present small calculi. In several there were varying shades of chronic pancreatic inflammation, and in one in whom this was quite marked following re-operation, death occurred from acute exacerbation. Hepatitis of some degree was present in a few cases in addition to cholangectasis as noted in the patient just referred to. In no other instance was it very marked.

The interval elapsing between cholecystectomy and the onset of symptoms varied considerably. In 2 cases there seemed to be no clear interval before symptoms recurred after operation. In 5 cases the interval was somewhat short of a year, while in 4 it was over 5 years. Following the development of symptoms, 2 of these patients required re-operation within less than a year while 9 of them did not seek further surgical attack until after 5 years had elapsed.

In the majority of cases, the symptoms were described as being identical or similar to those of the original trouble. In 3 patients who had had questionable or definite jaundice with the original trouble, this symptom was present in the recurring attacks. In 6 others jaundice of some degree developed with the new difficulty when it had not been present with the original trouble and in 3 of these jaundice was marked.

An analysis of the pathological findings in this group together with the symptoms from which the patients complained leads to the conclusion

[1]From the Department of Surgery, College of Medicine, University of Iowa. Presented before the Western Surgical Association, St. Louis, December 7, 1934.

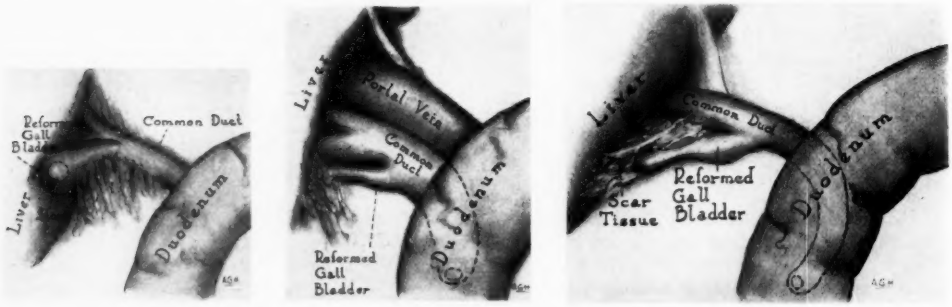


Fig. 1. Three cases of simple "reformed gall bladder," one of which contained a calculus.

that a "reformed gall bladder" is a definite entity as a sequel to cholecystectomy and that it may be responsible for symptoms and complications similar to those developing in a diseased gall bladder. In any given case, however, in which there was present associated pathological change, it was impossible to ascribe the patient's complaints entirely to the "new" gall bladder. The latter might be an accidental finding.

Certainly in the 3 patients in whom the common duct harbored calculi, the symptoms cannot be charged solely against the "new" gall bladder. The stones may have been present at the original operation. In one case, however, the stone found lodged in the common duct ampulla was of the size and shape of the "new" gall bladder, suggesting that it may have represented a cast of the pouch and had been extruded into the common duct.

It seems reasonable to conclude that not only may a "reformed gall bladder" be responsible for symptoms but that it should be chargeable to ineffectual surgery. In this clinic, emphasis has been placed upon the advisability of ligating the cystic duct close to its junction with the common when cholecystectomy is performed; therefore it is of interest to note that, of the 14 cases in this group, only 1 had been operated upon originally in this hospital.

B. Injury to the major ducts—11 cases. Surgical trauma to one or other of the major bile ducts as a complication of cholecystectomy is one of the serious hazards in this operation. In this series the postoperative course presented a fairly definite and rather common clinical picture. In some in whom drainage had been provided for through the abdominal wall, bile began to flow copiously almost immediately following operation and persisted as a biliary fistula until re-operation was carried out at a varying time subsequently. In others a period of 24 to 72 hours elapsed, during which time the patient became markedly jaundiced. Biliary drainage then established itself and there was improvement in the symptoms. In others the bile drainage, having been maintained for many weeks, finally stopped and the patient then became jaundiced and often had associated chills and fever. In 2 of the 11 cases, an anastomosis had been made between injured duct and duodenum before the patients came to this clinic and presented themselves here because of recurring difficulty. In one it was because of stricture of the anastomosis and in the other the symptoms were best explained on the basis of a pancreatitis.

The pathology involving the traumatized ducts was as follows: In 2 there was present an incomplete stricture at the junction between common and hepatic ducts which seemed to suggest that ligation of the cystic duct had included a considerable portion of the adjacent wall of the major duct, and in 1 of these there was angulation in addition to the narrowing and scar. The common duct had been completely severed in 9 cases: in 4, the patient entered the hospital with a biliary fistula which led to the dilated stump of the hepatic duct, while in the 5 remaining cases the incision had healed and the patient was deeply jaundiced at the time of re-operation. Two of these were the patients described who had been re-operated upon prior to entrance to this hospital. In 1 of these 5 the divided hepatic duct was represented by a mass of scar of such extent that no lumen could be found, although the dissection was carried to a high level into the hilus of the liver. Obviously the situation was not remediable and the patient succumbed.

In 1 of the 11 cases cholecystectomy had been performed in this clinic. Recognition of the fact that a portion of the common hepatic and com-

mon duct had been removed with the cystic duct, was made after the operation was completed and the specimen studied. By that time it did not seem that the patient's condition warranted immediate re-operation and reconstruction of the severed ducts. Biliary drainage established itself 3 days later and the jaundice which had developed cleared up promptly. The bile continued to drain through the incision freely but the patient succumbed from sepsis on the twentieth day after operation. Immediate re-operation might have been the wiser choice. In 2 other cases in this clinic the major ducts have been divided in the performance of cholecystectomy and with recognition of the situation during operation. Immediate reconstruction was made in each with a successful result in 1 and a fatality in the other.

The operative procedures which have been carried out in the 11 cases have varied with the condition encountered. In 5 it consisted of anastomosis between hepatic duct stump and duodenum, with a satisfactory biliary drainage into the bowel in 4 of these. In the fifth case, the patient in whom an anastomosis had been made elsewhere, the patient developed a massive stricture of the hepatic duct at the site of anastomosis and was operated upon in this clinic on three occasions in an attempt to maintain a permanent lumen. Following each operation, there was a period of 6 to 14 months of freedom from symptoms to be followed by recurrence of chills and jaundice as the stricture reformed. The patient finally succumbed.

In 2 patients anastomosis was made between the hepatic and common duct stumps over a "T" tube. In 1 the result was satisfactory. In the other a stricture developed after a period of several months, and at re-operation reconstruction of the duct at the site of stricture was made over an internally placed tube. This has been followed by a 6 year cure.

In 2 patients drainage of the dilated hepatic duct stump was carried out as a palliative procedure to get the patient in better condition for a reconstruction operation. One patient died. The other was found to have multiple chronic abscesses of both lobes of the liver. Her condition improved very markedly but she refused further surgical treatment and returned to her home with a draining biliary fistula.

With an analysis of the experience in this clinic with cholecystectomy and of these cases as a basis, it would seem that injury to the major ducts is more likely to occur in cases in which the technical difficulties of cholecystectomy are relatively slight. In pulling upon the gall bladder as a means of exposing its cystic duct, a sharp angle may easily be produced at the junction of common hepatic and common ducts so as to bring the common duct and the cystic duct in the same line and make the common duct seem a continuation of the other. It is easily explainable why, in such an instance, a clamp or ligature is thrown around the common duct and a segment of it taken away. This is likely to occur when the ducts and the gall bladder are relatively elastic and the procedure seems to be simple. In cases in which the disease of the gall bladder and the pericholecystic structures is more marked, the surgeon is likely to proceed with greater care and tugging upon the gall bladder is less likely to angulate the major ducts.

Fig. 2. "Reformed gall bladder" associated with angulation and constriction of the common duct, together with considerable thickening of the pancreas. The "new" gall bladder was tightly adherent to the common hepatic duct.

C. Common duct stone—6 cases. In 6 patients re-operated upon following cholecystectomy, the major pathological finding which reasonably explained the recurrence of symptoms consisted of calculi in the common duct. In 3 other instances, as stated in the discussion of "reformed gall bladder," stones were present in the duct.

In these 6 patients an analysis of the symptoms antedating cholecystectomy and those which followed the operation lead to the conclusion that the calculi were present in the common duct at the time cholecystectomy was performed without much question in 2 instances and probably in a third. In a fourth case the findings at operation were such as to make it unlikely that stone was present in the common duct when the gall bladder was removed. In the 2 remaining cases in addition to cholecystectomy the common duct was opened for the removal of stones and in each instance the duct was of such caliber that the

Fig. 3, left. "Reformed gall bladder" associated with angulation of the common duct and calculus in the ampulla of Vater. The stone was of the size and configuration of the "new" gall bladder and suggested that it probably had formed within it, to be subsequently extruded.

Fig. 4. "Reformed gall bladder" with a fistulous tract communicating with the duodenum. The common duct was angulated and somewhat constricted.

little finger could be introduced within it and an accurate determination made that no stones were left behind. In each the patient returned after a period of many months with recurring trouble and at re-operation new stones were removed from the duct. In each again the finger could be used to prove that all calculi had been taken away. In one of these patients, after an elapse of several more months, stones of considerable size reformed once more.

The incidence of common duct stone in these 66 cases of re-operation following cholecystectomy would seem to be surprisingly small, comprising as it does only 6. The development of calculi in the common duct was proved to have occurred in at least 2 cases *following* cholecystectomy, and it probably took place in 2 others.

D. Angulation of the common duct—2 cases. In addition to those patients who suffered trauma to the major ducts at the time of cholecystectomy or who harbored stones in the common duct either before or after cholecystectomy, there were 2 patients who required operative treatment because of mechanical distortion. These are in addition to those patients who had pathological changes of this character in association with a "reformed gall bladder" as already described.

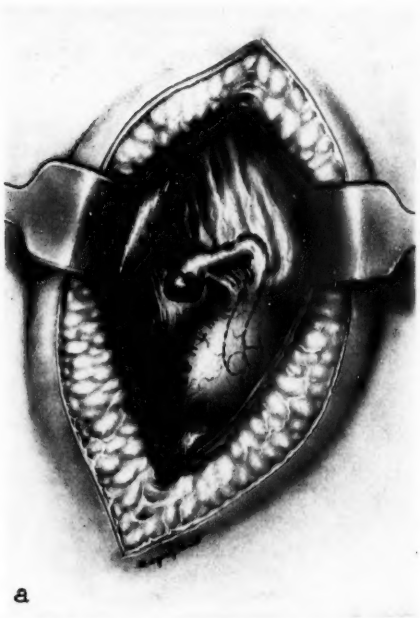
In 1 instance there was found a stump of cystic duct about three-fourths of an inch long but which was not dilated and could not properly be classified as a "new" gall bladder. This cystic duct stump was fixed to the gall-bladder bed by scar and sharply angulated the major ducts in consequence. A second patient, operated upon in this hospital, had a cholecystectomy and drainage of the common duct following the removal of many common duct stones. Two weeks following the removal of a "T" tube, which had been placed in the common duct for drainage, the patient developed an attack of pain associated with jaundice. At re-operation 7 months later, with a pre-operative diagnosis of common duct stone, no calculi were found, but there was present a very sharp angle between common hepatic and common ducts at the site of the former tube drainage. This distortion was produced by scar to the gall-bladder bed in the liver.

RECAPITULATION

A review of the cases in the four groups just described suggests certain points in respect to the technique of cholecystectomy and common duct surgery.

It is quite clear that a surgeon must chart an accurate course across the cystic duct to avoid the Scylla of a "reformed gall bladder" on one side and the Charybdis of major duct injury on the other. The answer does not seem to lie in one's choice of performing cholecystectomy by beginning the dissection of the gall bladder at the fundic end or only after the cystic duct has first been exposed and divided. On the basis of personal experience with each, it would seem that both modes carry the same inherent dangers. In this clinic, as a routine, removal of the gall bladder is begun at the cystic duct end.

Accurate identification of the cystic duct in relation to the major ducts is essential to division



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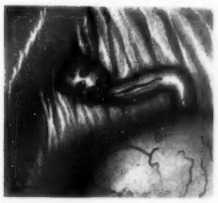


Fig. 5. a, "Reformed gall bladder" containing a calculus, with marked angulation and constriction of the common duct. The dilated hepatic ducts contained many calculi. b, The constricted common duct after the "new gall bladder" was dissected free and removed. The biliary tree was subsequently visualized by the introduction of lipiodol through the draining "T" tube for roentgenographic study, and marked cholangectasis was shown.

of it at the proper level. This is difficult in cases in which there is present a massive inflammatory reaction, recent or old, in the mesocysticum, and especially if there is distortion of the anatomical relationships from scar contraction. A careful deliberate dissection is necessary, and it is best carried out bluntly. There is no need for isolating the cystic artery independently. After the cystic duct has been completely freed in a given area from the cellular tissue in the mesocysticum, any traction applied through the gall bladder should be relaxed so as to permit the major ducts and the cystic to assume their normal positions, and only then should a clamp be placed across the latter. This should traverse the cystic duct at its junction with the common and the jaws of the clamp must not include any of the tissue beyond the isolated duct. A second clamp is then applied parallel to the first and division made between them.

A curved hemostat is now placed close to the proximal stump of the duct and the gall bladder, and directed obliquely across the mesocysticum toward the gall-bladder bed. This will usually include the cystic artery if the latter has not already been secured by the clamp across the cystic duct. With scissors, division is made between the hemostat and gall bladder.

Before proceeding with further dissection of the gall bladder, the clamp on the mesocysticum is replaced by ligature following which the duct stump is ligated. Two ligatures of No. 3 plain catgut are placed on the stump. This heavy ligature is used as it does not cut the duct and lead to biliary leakage.

In proceeding with the removal of the gall bladder, incision is made through the peritoneal investment on each side so as to leave flaps, and these are sutured across the gall-bladder bed to control oozing and to minimize the raw surface to which adhesions may form with adjacent viscera. This is important as a means of preventing angulation of the major ducts and angulation and fixation of the pylorus or duodenum from scar.

In cases in which attack is to be made upon the common duct in addition to cholecystectomy, it is usually best to proceed with the former as the first step because the gall bladder and its duct may be invaluable for a landmark and for traction.

In respect to the problem of common duct stone, a surgeon is faced with the humiliation of failing to detect and remove a stone on the one hand, and certain postoperative complications and sequelæ from opening a common duct

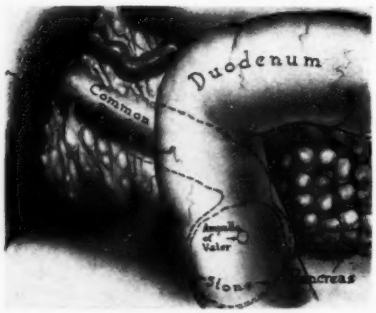


Fig. 6. Large calculus in the ampulla of Vater which probably developed following cholecystectomy. Note the unusual position of the papilla of Vater (incorrectly labeled ampulla) due to the marked pouching of the duct.

needlessly, on the other. *The common duct cannot be opened with impunity.*

In every patient upon whom operation is performed for gall-bladder disease in an interval between attacks, examination by palpation of the common duct should be carried out routinely. As has been emphasized by Bevan, this is best done by standing upon the patient's left side and passing one's left index finger behind the gall bladder so that it enters the foramen of Winslow and is, therefore, directly behind the common duct. With the thumb in front, palpation can be carried out along the entire extent of the duct and the pancreatic head. It is in the latter region that a stone is most likely to be missed.

While many writers have stressed the fact that common duct stones may be symptomless, special attention to possible stone in the common duct is given to patients in whom jaundice in any degree has been present in any attack or in whom apparently uncomplicated gall-bladder attacks have been associated with chills. A dilated common duct should arouse interest in a possible common duct stone, although a shriveled, completely functionless gall bladder commonly leads to functional dilation of the common duct of considerable degree.

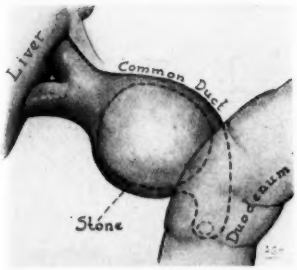
When drainage of the common duct by "T" tube is instituted, great care is taken to repair the duct incision accurately to the point of emergence of the vertical limb. For this, No. C machine twisted silk on a fine, curved needle is used with interrupted stitches and each bite picks up the full thickness of the duct wall to include the mucosa. This has proved more efficient than catgut either as a running or interrupted stitch. After cholecystectomy is completed, a running stitch of fine catgut repairs the serosa over the common duct to cover the suture line in the latter, and is continued on to the gall-bladder bed.

The "T" tube is brought through the incision or through a stab wound to the right, depending upon which point seems more direct. The tube in its position between common duct and parietal peritoneum *must not be too taut* or angulation of the major ducts may be produced, and this lead to permanent distortion or predispose to narrowing or scar constriction subsequent to removal of the tube. With marked distention of the abdomen or in violent movements of the abdominal wall during vomiting or coughing, after operation, the tube may become dislodged from the sutured duct, the suture line give way, or the duct may be completely torn across.

Injury to the common and hepatic ducts during cholecystectomy, or from inflammation, or due to postoperative mishaps, leads to pathological situations of grave surgical import. Each case is a distinctly individual problem. Not the least of the technical difficulty is due to the extensive adhesions which are invariably present and the necessity for a painstakingly careful dissection to expose the biliary tract and avoid injury to adherent viscera.

If the major duct has been completely severed and a fistulous tract leads from the skin to the hepatic stump, exposure of the latter is relatively easy. With or without a fistula, the stump is usually dilated and tense and may contain calculi. The duodenal end may be short and so small in caliber and buried in scar that it cannot be recognized without a retrograde sounding through the opened duodenum—a procedure of questionable merit.

End-to-side anastomosis between the stump of the duct and the adjacent duodenum is usually the operation of necessity. Mobilization of stump and bowel should be done to permit of union without tension. Interrupted stitches of twisted silk are used, accurately placed so as to pick up the full thickness of duct and duodenal wall. In uniting the posterior margins, the stitches are placed within the lumina and the knots lie in contact with the mucosal junction. When the angle is reached above and below and suture of the anterior margins is made, the stitches are placed so that the knots lie externally. *Accurate contact which includes mucosa* is essential to obtain substantial union and to minimize the danger of subsequent stricture. Reliance upon a rubber tube to bridge a gap between duct end and duodenal wall is hazardous. The scar tissue which reforms the duct in the gap, is very likely to contract after the tube has passed or has been



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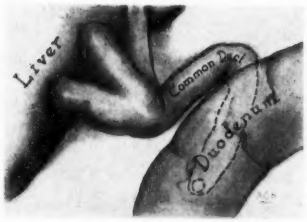

Fig. 8.

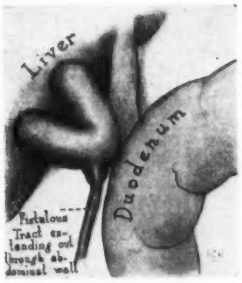

Fig. 9.

Fig. 7. Bantam egg sized calculus in the midportion of the common duct which presumably developed following cholecystectomy. The patient was free of symptoms for 5 years following removal of the gall bladder.

Fig. 8. Marked angulation producing obstruction of the common duct following the operation of cholecystectomy.

Fig. 9. Injury to common duct which was incurred during cholecystectomy followed by the development of a biliary fistula leading to the greatly dilated stump of the hepatic duct.

removed (where a "T" tube is used) and a hard, impermeable stricture develops.

The suggestion has been made of utilizing a fistulous tract from skin surface to duct end as a means of establishing a communication with duodenum or stomach, by mobilizing the fistula by dissection, and introducing the skin end into bowel or stomach. As the fistulous tract is usually tortuous and narrow and lined throughout with scar, or unhealthy granulation tissue, this procedure seems of very dubious value.

In some cases of complete division of the major duct, the duodenal segment lies in close proximity to the hepatic stump so that end-to-end reunion of the two is possible. The duodenal portion of the duct is often of small caliber and the disproportion between it and the dilated hepatic segment is marked. Dilatation of the small calibered portion is often feasible until approximately the same size as the other. In this clinic, special sounds[1] have been devised for this purpose, of such length, curvature, and gradation as will permit of their ready introduction into the duct and its gradual dilatation without injury.

Obstruction of the duct by intrinsic scar is usually a difficult condition to remedy. Sometimes the stricture is limited to a small segment of the duct, as it may be when it develops at the site of former "T" tube drainage, or following incomplete division during cholecystectomy. Depending upon the degree of obstruction, the proximal segment is dilated and often contains stones or "bile mud," and the distal segment is usually contracted.

In such a case the operative attack may be relatively easy and will consist of an incision in the long axis of the duct to straddle the stricture. The proximal limb is emptied of any foreign material by forceps and saline flushing, and the distal limb is carefully and gradually dilated by sounds until it is approximately the caliber of the proximal. The incision is then closed by interrupted sutures, *in the transverse axis of the duct.* This secures a liberal lumen at site of stricture. This procedure is not feasible if the duct wall on either side of the stricture is thickened and inelastic.

When the duct is extensively involved by scar, there are three courses for the surgeon to pursue. Which one shall be chosen in a given case is an individual problem and may be difficult to decide. Before he is through with the case, the surgeon is likely to wish that he had decided differently. These consist of: (a) resection of the scarred segment of duct and re-establishment of continuity by end-to-end anastomosis; (b) division of the duct proximal to the scarred area to be followed by anastomosis between the duct end and the side of the duodenum; (c) dilatation of the contracted duct, and drainage of it by tube for a long period of time.

The latter course usually will be the only feasible one, due to the extent of the pathological change in the duct. The terminal portion is often markedly involved and the duodenal wall at the site of emergence of the duct is commonly indurated and unyielding and producing obstruction. It is in a situation of this sort that the graded common duct sounds have proved invaluable in this clinic. The duct is incised in its long axis and in the most accessible area. The largest sound which can be introduced without force is selected, anointed with liquid petrolatum, and slowly and gently passed to the left until it enters the duodenum through the papilla of Vater.

[1] These are of value in any case of surgery of the common duct to outline the course of the duct or to determine the presence of calculus. Before introducing a sound, it is anointed with liquid petrolatum.

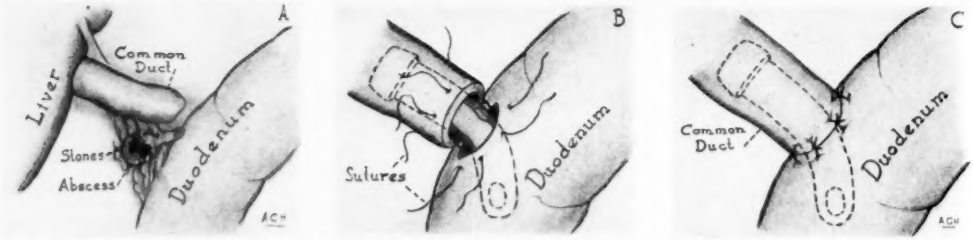

Fig. 10. A, Injury to common duct during cholecystectomy with a closed dilated duct stump. A small chronic abscess containing calculi is present and has established drainage through the wall of the duodenum. B, Anastomosis between the duct end and the side of the duodenum was made, enlarging the opening in the latter through which the abscess was draining. C, Completed anastomosis. Suture was made over a piece of catheter and a rubber flange constructed to help maintain the tube in position for considerable time.

It is then withdrawn and passed to the right. The next largest sound is now used; by gradually increasing the size of the sounds, and always working with great gentleness and deliberation, a surprising degree of dilatation can be obtained in the majority of cases, and without trauma to the duct.

Drainage of the duct should be established by either the internal or external route. For the former, a catheter may be used of such size as will easily lie within the dilated duct and papilla of Vater. Its duodenal end should protrude 2 to 4 inches into the bowel, and the proximal end extend well to the right of the incision in the duct. The latter is accurately closed by interrupted stitches of silk and reinforced by a serosal stitch of catgut. The method of internal drainage is ideal in these cases except that one has no accurate control over the length of time during which the tube will be maintained in the duct. Without some mode of fixation, the tube will usually be passed into the bowel in from 7 to 14 days, which is unfortunate because recurrence of the common duct scar contraction usually follows. Some control of the tube in the duct can be secured as shown in Figure 13. By this technique the tube will remain in the duct from about 3 weeks to years, depending upon the maintenance of the suture material in the duct wall.

Drainage by the ordinary "T" tube offers a means of control of the period of drainage. The outstanding objection to its use lies in the fact that the intraductal portion of the tube is not sufficiently long to pass through the papilla of Vater, and this segment of the duct may promptly close down following dilatation.

In this clinic a special "T" tube is used in cases of this sort, with a long intraductal portion. The duodenal end is cut off at a point which permits it to lie within the bowel for a distance of 2 to 4 inches beyond the papilla of Vater. As in all cases of "T" tube drainage, suture of the duct wall around the external limb is carried out with the utmost care.

Following operation, fluid can be safely given through the tube if desired, and in all cases, after the first few days after operation, from 200 to 300 cubic centimeters of warm tap water are introduced into it daily, to keep it flushed out. This causes the patient no concern; in fact, there is no sensation whatever produced in most instances. The tube can be maintained in place for an indefinite period of time and is just as easy of removal as is the ordinary type. One patient has worn such a tube for nearly a year without difficulty, and her common duct was so markedly pathological, that the tube will probably be left *in situ* as long as she lives. Twice each day she introduces a small amount of water into it through the external limb and the rest of the time shuts it off by a rubber band.

E. Faulty repair of the incision—19 cases. Following cholecystectomy, difficulty in respect to the incision may develop as an early postoperative complication or at a varying period of time later after healing has been apparently complete.

Wound separation occurred in 8 instances and of course represented cases operated upon in this hospital. Only such cases are included in this group as were treated by resuture rather than by any form of non-operative support. The degree of separation varied but in most instances would be classified as complete and associated with some evidence of evisceration. This alarming complication sometimes developed abruptly but in most cases there were symptoms which suggested that separation of the wound had begun in the deeper layers before the evidence of the serious situation was manifested through the skin incision. In 4 patients there was rather

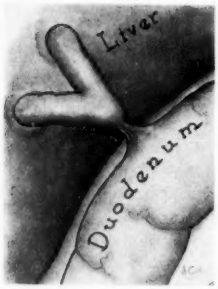

Fig. 11. Development of excessive scar with resulting stricture and obstruction at the site of anastomosis between hepatic duct stump and duodenum. The common duct had been injured during cholecystectomy.

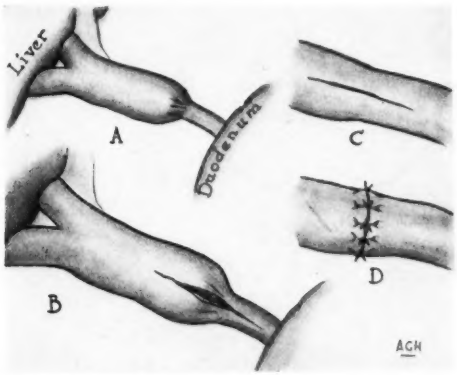

Fig. 12. A method of attacking a stricture of the common duct limited to a short segment of the duct. Following incision through the stricture in the long axis of the duct, *B*, the contracted distal segment is dilated by graded common duct sounds until it is approximately the caliber of the proximal portion, *C*, and then the incision in the duct is sutured in the transverse axis, *D*.

obstinate vomiting in the early postoperative course suggesting a potent etiological factor. In 1 case there was obvious wound infection. In only 1 of the 8 cases was cholecystectomy associated with common duct drainage. The separation occurred through the sixth to the twelfth postoperative day, the average being the ninth day.

The seriousness of this complication is shown by the death of 4 of these 8 patients.

Incisional hernia requiring surgical repair occurred in 11 patients, of whom 5 had had the cholecystectomy performed in this hospital. In this group of 11 the presence of a hernia was manifested in 2 as soon as the patient got up following operation. In 1 patient the interval was 5 years. In 8 of the 11 patients herniation was noted at some time during the first year. As a predisposing factor in the postoperative course, vomiting was pronounced in 2, a cough was blamed in 2, marked distention in 1, and a wound infection in 1. In the rest of the cases no predisposing factor could be elicited either from the history or the record.

Undoubtedly, incisional hernia following cholecystectomy occurs much more frequently than this small group of cases signifies. A hernia in the right upper quadrant may be complacently tolerated by a patient and often an abdominal support will control distressing symptoms. Danger of strangulation is relatively much less than in incisional hernias in the lower half of the abdomen.

Postoperative wound separation or the subsequent development of an incisional hernia cannot lightly be ignored as a complication of, or sequel to, cholecystectomy. In the former the risk to life is great, and in the latter the disability may be marked. The importance of adequate and secure closure of the abdominal incision at the time of cholecystectomy cannot be sufficiently stressed to a surgical staff. Closure of the incision is boresome to many surgeons and is commonly delegated to some junior, in spite of the fact that this portion of the operation will occasionally be as difficult and require as much skill and attention to detail as the removal of the gall bladder.

The conclusion has been arrived at, from an analysis of cases of wound separation in this hospital and operations for incisional hernia following cholecystectomy, that the posterior sheath of the rectus commonly gives way first which leads to a wide separation of the peritoneum and, what is more important, of the transversalis. This puts an undue stress upon the anterior sheath which either soon gives way because of the tearing through of sutures, or at a later time begins to stretch until a hernia is the end-result.

A deep wound separation often produces a clinical picture which is diagnostic. It is that of a high incomplete intestinal obstruction and the outstanding early symptom is repeated vomiting. One is likely to blame the vomiting for the giving way of a wound, whereas it is really an effect rather than a cause. When the abdominal wall gives way from within, the pyloric end of the stomach and first portion of the duodenum or loops of jejunum or ileum, together with omentum and hepatic flexure of the colon, may fill the deeply situated defect. Distortion of the gastrointestinal tract may take place to produce me-

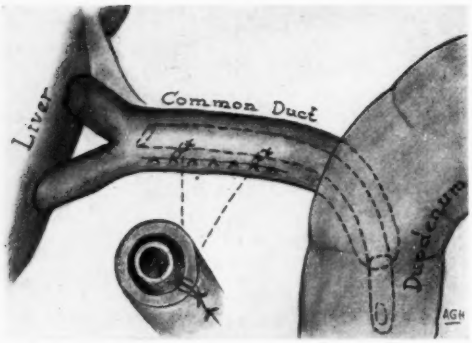

Fig. 13. To demonstrate a simple way of maintaining an internally placed tube within the common duct for considerable time. Loops of silk are placed in the side of the tube and these are caught in interrupted stitches which close the incision in the duct. The tube will pass into the intestinal tract when the stitches finally work through the healed duct wall.

chanical obstruction in considerable degree and abdominal distention follows. There may be no undue elevation of temperature or leucocytes, the wound appears to be secure, and the patient is usually treated for paralytic ileus.

In this hospital there has been a very definite decrease in the incidence of postoperative wound separation and in the development of incisional hernia with the passing years. It is felt that this is due to two factors: (1) Constant emphasis has been placed upon the importance of meticulous care in incisional closure. The necessity for including the transversalis muscle as well as the peritoneum in the suture of the posterior rectus sheath is stressed. It has been found that a generous bite of the posterior sheath parallel to the incision, rather than at right angles to it, tends to minimize the tendency of this structure to split. A running stitch of doubled catgut is used and this is locked frequently as it is continued. A proper closure is often time-consuming but it is time well spent. (2) The use of ethylene for basal anesthesia. While ether must usually be added, it is in relatively small amounts and the incidence of postoperative vomiting and pulmonary complications with cough is definitely lessened.

F. Postoperative infection within the peritoneum —6 cases. These patients were all operated upon in this hospital and with one exception represented conditions with marked pathology. In 4 of the latter, besides cholecystectomy, the common duct was opened for the removal of stones.

In 1 patient a pelvic abscess developed as a postoperative complication which was drained through the rectal wall with recovery. In 2 patients a subhepatic abscess formed. In 1 this developed during convalescence and the abscess contained bile as well as pus. In the other, many weeks elapsed but the same character of content was present in the abscess and the latter led to the stump of the cystic duct. In each case the establishment of adequate drainage was followed by a prompt recovery.

In the 3 remaining patients the infection developed under the diaphragm and in each it was situated posteriorly. In these cases no bile was present within the abscess. In 2 of this group pericholecystic abscesses were present at the original operation in addition to stones in the common duct. In all of these cases the subphrenic abscess was drained through the thoracic wall posteriorly with recovery.

In another case not included in this series, there was clinical evidence of a subphrenic accumulation of considerable amount. The first stage of a planned 2 stage drainage through the thoracic wall posteriorly was performed. A few days later very free drainage of bile was spontaneously established through the abdominal incision with complete relief of all symptoms, and the patient went on to a cure without completion of the subphrenic drainage.

The possibility of contamination of the general peritoneal cavity by septic material is obvious in any operative attack upon the biliary tract. This danger is increased when the procedure is technically difficult and when infected bile escapes in quantity from opened duct or gall bladder. To prevent widespread contamination, great care should be taken to protect the operative field by properly placed lap pads, and the generous use of a "sucker" throughout the operation is a potent means of controlling the dissemination of infected fluid into the peritoneal cavity.

The deep recess below and behind the gall bladder is an especially critical area because infected material can so easily gravitate into it and subsequently infection may spread between liver and diaphragm to produce a subphrenic abscess. It is wise to carry a strip of iodoform or plain gauze into this area as a coffer dam before proceeding to any attack upon common duct or gall bladder. At the conclusion of the operation a strip of gutta percha or small tube had best be carried to this area for drainage.

G. Miscellaneous—8 cases. Cholecystectomy was performed in this clinic on a patient in whom there was a recurrence of similar attacks after a lapse of 3 months. Before and following operation there had been chills and some degree of jaundice

Fig. 14. Diverticulum of the duodenum at the site of the papilla of Vater. This produced symptoms suggesting cholecystitis and led to cholecystectomy. The symptoms recurred, and restudy of the patient disclosed the diverticulum. He has been cured by anastomosis between the enormously distended common duct and the duodenum. The diverticulum was situated in the posterolateral aspect of the second portion of the duodenum. The latter and the common duct are shown in a rotated position to demonstrate the diverticulum.

with the attacks. No stones had been found in the common duct and the pancreas seemed normal. At re-operation there was no evidence of a "reformed gall bladder"; the pancreas and liver both seemed normal. The common duct was opened and no stones were present within it. It was dilated so that the little finger could be used for palpation. The wall was considerably thickened and subacutely inflamed. This seemed to represent a condition of common duct inflammation independent of other demonstrable causes.

A patient developed attacks of biliary difficulty 3 years following cholecystectomy and operation was begun but terminated because of injury to the duodenum. Patient succumbed and postmortem examination uncovered an acute pancreatitis together with marked chronic change in this organ. The common bile duct presented no evidence of pathology and contained no stones and the liver was normal.

Cholecystectomy was performed for symptoms strongly suggesting biliary tract disease associated with jaundice. The patient had syphilis. Adequate explanation for her difficulty seemed to lie in gall-bladder disease. There was no evidence of disease of the liver. Symptoms recurred after a period of 1½ years. Re-operation uncovered no satisfactory explanation for the recurrence of symptoms on the basis of demonstrable disease in the biliary system including the pancreas.

Fig. 15. To show how traction upon the gall bladder during cholecystectomy will bring the cystic and common ducts into the same line. The surgeon may then mistake the common duct for the cystic and crush it by clamp or ligature.

Cholecystectomy was performed here with a diagnosis of recurring cholecystitis. No stones were present, but the gall bladder seemed to present satisfactory evidence of disease to explain the symptoms. Two years later the symptoms recurred but were associated with chills. There was no jaundice. Pre-operative study disclosed the presence of a diverticulum of the duodenum in its second portion. At re-operation a common duct 5 centimeters in diameter was disclosed and a diverticulum the size of a hazelnut was present in the region of the papilla of Vater. The common duct was opened and found to contain no stones. An anastomosis was made between it and the duodenum. The patient has been relieved of all further symptoms for 2½ years.

Cholecystectomy was performed in this hospital and on the second day continued bleeding manifested itself through the wound. Incision was reopened and large clots together with fluid blood were found in the operative area. There was no active bleeding point.

Cholecystectomy in this hospital was followed on the tenth postoperative day by the symptoms of intestinal obstruction. Operation was performed and a loop of small intestine was found tightly adherent at the lower angle of the wound. Possibly it had been fixed in the peritoneal suture. The patient succumbed.

Cholecystectomy performed here was followed by obstinate vomiting which persisted for 5 months. Re-operation disclosed a pyloric obstruction due to fixation of the pylorus and first portion of the duodenum against the liver in the hilus area. Posterior gastro-enterostomy was performed with an excellent result. In a somewhat similar case a second operation was done elsewhere and

therefore is not included here. In this instance the obstruction manifested itself during the hospital convalescence. Re-operation was carried out on the twelfth postoperative day. Gastro-enterostomy was followed by complete recovery. Adhesions between the viscera in the hilus area and especially involving the duodenum always develop in some degree after cholecystectomy and are probably responsible for some of the lesser complaints following operation. Careful handling of tissue, complete hemostasis and peritonealization of the gall-bladder bed by suture will tend to minimize the formation of adhesions.

Cholecystectomy was performed on a patient in this hospital and a stone impacted in the ampulla of Vater was removed. A small opening was inadvertently made in the posterior wall of the duodenum by a probe passed into the common duct. This opening was repaired by suture. During postoperative recovery a duodenal fistula developed which failed to respond and gradually increased in size and in the amount of leakage. After many days the patient was re-operated upon. A posterior gastro-enterostomy was performed and the pylorus excluded by ligature in the hope of diverting the gastric content away from the duodenal leak. The patient succumbed.

CONCLUSIONS

1. A "reformed gall-bladder" may develop from dilatation of the stump of the cystic duct following cholecystectomy. This may undergo pathological changes and be responsible for pathological complications and produce symptoms in the same manner as a diseased anatomical gall bladder. It is chargeable to ineffectual surgery and can be prevented by ligating the cystic duct close to its junction with the common.

2. Injury to the major ducts is a constant hazard in the performance of cholecystectomy and leads to a critical situation which will require further surgical attack. The injury will vary from inclusion by ligature of a small portion of the side of the duct wall, to excision of a large segment of it.

3. In the performance of cholecystectomy, accurate identification and exposure of the cystic duct is essential. Avoid distortion, by traction upon the gall-bladder wall, of the anatomical relationships between the major ducts and the cystic when applying a clamp or ligature across the latter.

4. Stones in the common duct may be overlooked. Careful examination of the duct for possible stone should be made in every case before removal of the gall bladder, even though there have been no symptoms suggesting common duct stones. Of special significance are the history of jaundice in any degree during any attack; or the history of chills during attacks, which otherwise suggest uncomplicated gall-stone colic; or the finding of a dilated common duct at operation. Opening of the common duct for exploration should be limited to carefully selected cases. It cannot be done with impunity because of various serious sequelæ which may result.

5. Distortion and obstruction of the major ducts, or obstruction of the pylorus or duodenum in varying degree may follow cholecystectomy due to adhesions to the liver in the region of the gall-bladder bed. These sequelæ can be minimized by accurate hemostasis and by covering the raw surface with peritoneum.

6. Wound separation or subsequent incisional hernia are frequent and serious complications of cholecystectomy. Protracted vomiting as a postoperative symptom may be significant of a deep wound separation with incomplete high intestinal obstruction. Adequate, painstaking suture of the incision and the use of ethylene or nitrous oxide as a basal anesthetic tend to decrease materially the incidence of incisional difficulties.

7. Localized infection within the peritoneum may develop from contamination during a technically difficult procedure. Subphrenic abscess should be guarded against by protecting the space posterior to the gall bladder and common duct with gauze strips during operation on the biliary tract. Localization of the operative field by gauze pads and the generous use of suction limits the spread of infected material.

8. Isolated conditions may arise as complications or sequelæ which will demand surgical attack.

SURGICAL INDICATIONS FOR PEPTIC ULCER AND ITS SURGICAL MANAGEMENT

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AT present there are only three positive indications for the surgical treatment of peptic ulcer: perforation, pyloric obstruction, and, occasionally, severe and uncontrollable hemorrhage. More recent studies of the life cycle of peptic ulcer have definitely shown that patients having the deep penetrating type of ulcer can be permanently cured only by surgical intervention and that, therefore, this particular ulcer should be considered as a fourth positive surgical indication.

Other surgical indications are only relative, in that they depend first upon whether or not the physician in charge of the patient is surgically minded, and second upon the individual desires of the patient. It has long been believed that every peptic ulcer must first be subjected to medical treatment and, only when medical treatment has failed, dare there be consideration of surgery. The time necessary to determine whether or not medical treatment has failed is variable. In one of my patients who was finally referred for operation, it was more than 25 years. Much has also been said about first giving medical treatment a fair trial, but just what constitutes such a fair trial is still vaguely defined. As a prerequisite for the continuance of the present indications, it should first be ascertained if there is even a remote possibility of curing every peptic ulcer medically or if there are certain types of ulcer in which it can be determined in advance that medical treatment is doomed to failure. In a recent address Boas of Berlin, talking about the surgical indications of peptic ulcer, made this significant statement: "At the risk of being considered more surgically minded than the surgeon, not the number and length of medical cures but rather the character of the ulcer should be the determining factor." This seems to me to be the crux of the situation. For, if we were able to say to our patient in advance that his ulcer can or cannot be cured medically, many medical failures may be avoided, early surgical treatment instituted, and the patient saved much in suffering and expense.

The pathology of peptic ulcer is well understood. The ever present[1] polypoid gastritis has long since been recognized. It occurs both in gastric and duodenal ulcer, and, even if there were no other deterring agents, this inflammatory process itself would be sufficient to prevent healing. This in spite of the fact that digestive ulcers have the same natural tendency to heal as ulcers situated elsewhere in the body. Stomachs afflicted with polypoid gastritis are strangely reminiscent of the infected and hypertrophied urinary bladder which has been pounding against an obstructed outlet. In both organs the hypertrophy pervades the entire wall, most marked, however, in the muscularis. In the case of the obstructed bladder, the residual urine becomes foul and infected and gives rise to cystitis. In the stomach the greatly thickened gastric wall causes one to surmise a similar stagnation of contents, resulting in polypoid gastritis. When there is cicatricial contraction at the pylorus, the foregoing can be readily explained; in its absence the *raison d'etre* is more difficult to understand. It has been suggested[2] that a functional obstruction, a pylorospasm, occurring during the digestive act, might be equally efficacious. At any rate, there is good reason to believe that polypoid gastritis is in some way the result of an obstructed pylorus either functional or organic. This thought becomes more impressive when one pauses to consider that no other etiological factor has been discovered to explain this inflammatory phenomenon. Carrying this line of reasoning to its natural conclusion the inference is that free unobstructed drainage should have a beneficial effect upon the inflammation. Here again the obstructed bladder acts as a precedent. Healing in peptic ulcer is accomplished by granulation, the granulations beginning at the base of the ulcer and gradually extending to the surface. Unfortunately, however, in the lesions under consideration, the reparative process generally falls short of the mark, since the new and delicate granulations are infected and quickly destroyed by the omnipresent gastritis and duodenitis. With each successive infection the ulcer, in terrace-like formation, pierces more deeply until it finally penetrates into a neighboring organ or perforates into the free abdominal cavity. Obviously then a treatment to combat peptic ulcer successfully

[1] In a recent publication, E. Starr Judd and George W. Waldron (Surg., Gynec. & Obst., 1934, 59: 350) make the following statement: "And it is also realized that in this country we do not encounter the same type of lesion that the European surgeon has to contend with, the ulcer with an associated extensive gastritis." This has not been my experience. Since even with the naked eye, I was always able to find a high grade duodenitis and gastritis in all specimens removed. These findings were substantiated microscopically by both Dr. B. S. Kline, director of laboratories, Mt. Sinai Hospital, Cleveland, and Prof. Howard Karsner.

[2] This suggestion was first made to me by Dr. B. S. Kline.

Fig 1a.

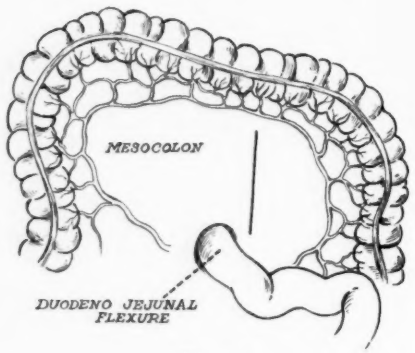

Fig. 1c.

Fig. 1b.

Fig. 1. a, Polypoid gastritis. b, Penetrating gastric ulcer with barium filled crater. c, Position of incision in transverse mesocolon. This incision is made to the left of midline in an avascular area.

must not only protect these delicate granulations but it must also cure the destructive gastritis and duodenitis, and eradicate the underlying pyloric obstruction, whether it be functional or organic. In this respect it must be admitted that medical treatment has been a dismal failure. Aside from these theoretical considerations, gastro-enterologists themselves, by publishing their final results, have brought striking proof of their inability to cope successfully with a large percentage of these ulcers.

Of the multitude of statistics available, those of Einhorn and Crohn, and those of David Smith, more than attest this fact. Einhorn and Crohn report 67 per cent cures after 1 year and only 22 per cent after 4 years. David Smith gives the immediate results in 214 cases treated between 1913–1922 as in Table I.

Sooner or later most of these uncured patients seek relief at the hands of the surgeon, giving the surgeon the opportunity to determine that the vast majority of these failures were penetrating ulcers. On the other hand, statistics gathered from surgical clinics located in all parts of the world, reveal upward of 90 per cent of permanent cures, with subtotal gastrectomy. Furthermore, in penetrating ulcer, medical treatment is far from safe, for experience has shown that not the superficial, acute ulcer, but rather the chronic, penetrating one is prone to perforate.

This being the case, how are we to diagnose ulcers which will not heal spontaneously or with medical treatment? Fortunately, such ulcers are easily recognized on the roentgenographic film, since as has already been stated, they are penetrating in character, and almost always contain a small amount of barium in the depths of the

TABLE I

	Cured Per cent	Dead Per cent
Immediate results		
Males	67	2
Females	76	5
Results 5 to 15 years later		
Males	29	19
Females	40	15

crater. It is this crater formation which distinguishes these intractable ulcers from the more tractable superficial ones. The latter cannot be seen roentgenographically and their presence may be surmised only by deformation of the roentgenographic contour of the stomach and duodenum. Such superficial ulcers in contrast to the penetrating kind will usually heal spontaneously or with medical treatment. If they do not, they soon become penetrating in character and join that large group of ulcers which can be cured only surgically.

I have been so fortunate as to observe several patients who have for many years undergone medical treatment for penetrating ulcers. Similar to other ulcer patients, they too had their periods of remission. During these periods, when the ulcer crater was filled with newly formed granulations, the ulcer as such could not be demonstrated roentgenographically. This led me to believe that a cure had been achieved. Sooner or later, however, the polypoid gastritis and duodenitis reasserted itself and destroyed these newly formed granulations, and once again the ulcer was in full bloom, and could readily be seen fluoroscopically with a fleck of barium in the depth of its crater. This cycle repeated itself many times. During the remissions these unfortunate patients have the false sense of security in believing that their ulcers have been lastingly cured. But, if the truth were known, they were verily standing on the brink of the precipice with that great medical catastrophe—perforated ulcer—constantly threatening them.

Bearing in mind the inadequacy of medical treatment and its attending dangers in penetrating ulcers, I believe myself to be justified in stating that penetrating peptic ulcers must be considered as a fourth definite surgical indication.

SUBTOTAL GASTRECTOMY

Subtotal gastrectomy for the cure of peptic ulcer secures upward of 90 per cent of permanent cures, and its mortality, when all factors are considered, is certainly no higher and probably lower than that of less extensive and less effective operations. However, there are still so many experienced workers in this field who disagree with this

Fig. 2. Stomach freed from its ligaments. Mass ligatures for hemostasis. Payr clamps applied at right angles to body axis.

statement and who still believe in gastro-enterostomy, that it would be obviously unfair to dismiss gastro-enterostomy from consideration without first stating its pros and cons in comparison to subtotal gastrectomy. The adherents of gastro-enterostomy claim that it will permanently cure 85 to 90 per cent of all peptic ulcers, with a death rate not in excess of ½ to 4 per cent. These results, they say, are equally as good as those obtained with the more mutilating and dangerous subtotal gastrectomy. If such brilliant results as set forth by the gastro-enterologists could be uniformly obtained by all surgeons, there would be no need of discussing or employing any other type of operation. But the very fact that there is so much discussion of other operations gives evidence that all is not well in the case for gastro-enterostomy. The following statistics relating to the cure of peptic ulcer with gastro-enterostomy are random selections from the literature, with the two exceptions of the figures emanating from the Mayo Clinic, and from Sherren's Clinic in London, which were purposely included, since these clinics are the leading exponents of the indirect method. A total of 5,572 carefully followed up cases were studied (Table II).

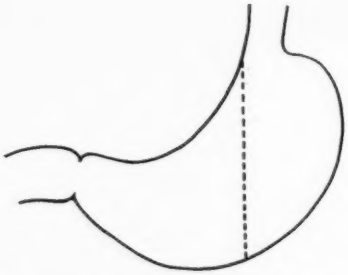

Fig. 3. Severing stomach at right angles to body axis (Finsterer).

Of these 5,572 cases, 71.7 per cent were reported as cures and partially satisfactory results. The most striking information obtained from the foregoing figures is the wide divergence in percentage of cures—from 47 per cent by Kaelin to 90 per cent by the Sherren Clinic and Metraux. This wide discrepancy is difficult to understand, and no attempt will be made to offer an explanation. It becomes more striking when the fact is taken into consideration that the above results were obtained in Class A clinics by competent surgeons using similar methods and similar technique. This fact, however, is clearly demonstrated—that uniformly good results are not obtained with the indirect method, and that at least 28 per cent of such operations completely fail to cure peptic ulcer.

The analysis of the statistics of the *resection method* gives an entirely different picture. Here in contrast to the statistics on gastro-enterostomy, the figures show a striking unanimity of results. The percentage of cures ranges from 82 to 98. Included in these statistics are those of Von Haberer, Moynihan, Finsterer, Strauss, Berg, the writer, and others. In the writer's own series, carefully followed by numerous personal contacts with the patients, the cures so far are upward of 90 per cent. Before leaving the subject of cures, it might be well to mention the fact that following the resection method, no dietary regimen is necessary, whereas on the other hand, the advocates of gastro-enterostomy insist upon continuous diet even after operation. This in itself is a paradox, for if gastro-enterostomy had cured these patients, why the necessity of further diet?

MORTALITY RATE

The next consideration, the mortality figures of these two operative types, can best be served by studying the death rate of large series of cases as reported by the leading exponents of the two methods. For this purpose the writer has selected

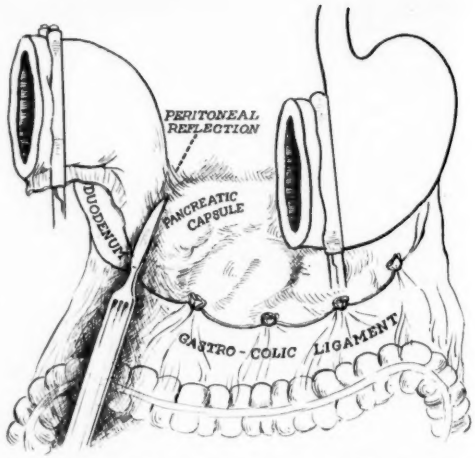

Fig. 4. Dissection of duodenum according to Berg's method.

2,229 gastro-enterostomies performed for both duodenal and gastric ulcer at the Mayo Clinic, and 3,122 partial gastric resections performed for the same illness at various clinics throughout the world.

The Mayo series gave an immediate mortality from all causes of 4.5 per cent in 545 cases of gastric ulcer, and 2 per cent in 1,684 cases of duodenal ulcer, a combined mortality of 2.6 per cent.

In 3,122 cases of gastric resection collected from 16 different clinics, there was a mortality of 5.76 per cent.

On the surface it appears that the death rate of gastro-enterostomy is somewhat less than that of resection, but only a slight scratching of the surface suffices to show the fallacy of this impression. Although the operative mortality for 2,229 gastro-enterostomies was only 2.6 per cent, there was an added mortality from all causes of 8 per cent in an average postoperative period of 3.5 years. How many of these fatalities were due to ulcer disease is not stated in the report. It is fair to assume, however, that a certain percentage of these individuals required secondary operation for either recurrent ulcer, jejunal ulcer, vicious circle, hemorrhage, or perforation. That such secondary operations entail an immensely higher mortality is an established fact. According to Clairmont, secondary operations have a death rate twice as great as primary operations, and in the case of jejunal ulcer, perforation, and hemorrhage, this may reach five to six times the initial rate.

TABLE II

Clinic	Cases	Cures — per cent
Sherren	500	90
Metraux	210	90
Mayo	1000	88
Paterson	447	78
E. Rovsing	64	76.4
Coffey	305	73.1
Hans Lehman	93	72
Solkov and Iljin	580	69.3
Sawkoff	327	69
Fremont Smith and McIver	412	67.2
Gatewood	163	66.8
A. Horwitz	17	64.7
J. Hohlbaum	32	56.2
P. Clairmont	289	56
Johns Hopkins	96	56
R. Wanke	179	52.5
R. Lewisohn	68	50
Schwartz	200	50
Schmieden	250	50
De Takats	270	50
Kaelin	70	47
	5,572	71.7

TABLE III.—FIGURES OF THE BRITISH ULCER COMMISSION.

	Cases	Deaths	Mortality Per cent
Duodenal ulcers	995	50	5
Pyloric ulcers	454	12	3.6
Gastric ulcers	538	48	8.9
Hour glass	65	8	12.3
	2,052	118	5.7

When this high secondary mortality is added to the initial death rate it is evident that the mortality of gastro-enterostomy is considerably higher than is generally supposed. The many reports at hand conclusively demonstrate that such complications as mentioned are only very rarely observed following the more extensive operation. *Secondary mortality following the resection method is practically nil.* In his own series, the author has seen not a remote complication following the resection method which was either directly or indirectly attributable to the original ulcer. Without this high secondary mortality the death rate of the resection operation is certainly not higher than that of gastro-enterostomy; if anything, it is considerably lower. That the immediate mortality of resection is capable of further reduction is proved by the fact that von Haberer was able to operate upon 99 patients, consecutive cases, without a death, Gatewood, 30, and the author, 37.

In leaning backward in an effort to be fair to the adherents of gastro-enterostomy, I have used the figures emanating from the Mayo Clinic as a standard for the mortality rate. Not all clinics have been able to match these statistics. Moynihan, analyzing the 2,052 cases collected by the British Ulcer Commission in England (A. Rendle Short), records an immediate mortality of 5.7 per cent, ½ per cent higher than that which obtains in the resection method.

Fig. 5. Method of closing blind end of duodenum.

Jejunal ulcer, a condition unknown before the advent of gastro-enterostomy, has been variously estimated as occurring in anywhere from 5 to 30 per cent of gastro-enterostomies (von Haberer, Finsterer, Strauss, Lewisohn). That the frequency of this condition is generally underestimated is borne out by the fact that 4 such cases came under the writer's personal observation in the short period of 2 years. The etiology of this condition, as that of peptic ulcer in general, is still considerably in doubt. Nevertheless, its almost complete absence following the resection method gives rise to the thought that hydrochloric acid must play a very important rôle in the causation of this type of ulcer. Several isolated instances of marginal ulcer have been reported following the Billroth II operation. It is quite possible, however, that these were due to an incomplete resection. Following the Billroth I, there is not a single authentic case (personal communication to the author from von Haberer).

As for the claim of pernicious anemia following the resection method, suffice it to say that literature records only a very limited number of such cases, in some of which it appears that the diagnosis has not been clearly established. When this small series is compared to thousands of recorded cases of subtotal gastrectomy, of more than 5 years' duration, this alleged source of danger shrinks almost to the vanishing point.

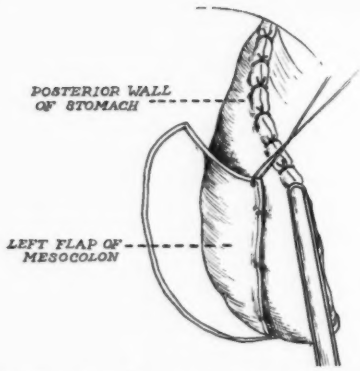

Fig. 6. Upper half of remaining portion of stomach completely sutured (Hofmeister-Finsterer method), left flap of mesocolon attached to the posterior stomach wall.

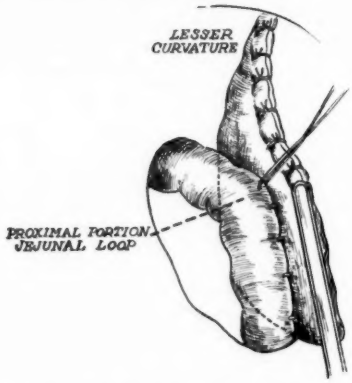

Fig. 7. Jejunal loop sutured to posterior stomach wall. Proximal portion of jejunal loop directed toward lesser curvature of the stomach.

What has been said about gastro-enterostomy appertains for the most part to the various pyloroplasties. Since these operations neither eradicate the underlying duodenitis and gastritis nor produce a reduction in the gastric acidity, it is quite obvious that they cannot routinely cure duodenal ulcer for which they have been especially devised. If the stated facts concerning these operative procedures for dealing with peptic ulcer are impartially weighed, there can be only one answer, namely that, in the light of our present knowledge, subtotal gastrectomy is the only procedure which will consistently bring about a permanent cure for this disease.

TECHNIQUE

The following description of the technique is given in considerable detail in the hope that the operation of subtotal gastrectomy may become standardized and more generally employed by both the gastric and the general surgeon. The advantages of standardizing operative procedure are well illustrated by the operation of thyroidectomy. Before thyroidectomy was standardized it was so dangerous that it was attempted only by the expert. Today, since it has been standardized, it is one of the safest operative procedures, and large series, with only an occasional death, are constantly reported. I claim neither priority nor originality for the technique which I am about to describe, for I have merely taken the best points from the technique used by others, and only here and there added a slight modification of my own. I do claim, however, that all of these procedures have been thoroughly tried by me, and that when they are carefully and painstakingly carried out, subtotal gastrectomy is just as safe as any other major abdominal operation.

Any patient who shows one or more of the surgical indications previously discussed is a candidate for this operation. Only those patients who have uncompensated heart lesions, severe nephritis, etc., are excepted. Advanced age is not a contra-indication. A number of our patients were between 60 and 70 years of age and stood the operation exceptionally well. Neither need surgical shock, even in old patients, be feared; it is a most rare complication. This is proved by the fact that in only a very small number of cases was it necessary to perform a postoperative blood transfusion.

Pre-operative treatment. If the patient is seen during an acute exacerbation, he is put to bed and placed on a suitable diet until all symptoms have subsided. The regimen which we most frequently use is the Sippey diet but any of the other well known diets answers equally well.

The immediate pre-operative treatment varies according to the case. If there is food retention, gastric lavage with an old fashioned stomach tube is performed twice daily for 2 or 3 days; a Levine tube is then inserted through the nostril for an additional 2 or 3 days until the fluid returns clear. During this time the patient receives only sterile food.

If there is no food retention, the patient receives a sterile diet for 24 hours and a gastric lavage the morning before the operation. Pre-operative medication consists of either morphine or pantopon and atropine 1 hour before the patient is

Fig. 8. Anastomosis completed.

taken to the operating room. If necessary, a sedative, such as one of the barbituric acids, is given the previous evening.

Selection of the anesthetic is of great importance; some form of regional anesthesia should be employed. Three methods are available: ligamentary (Finsterer), splanchnic, or subdural block. With the first method I have had no experience. Splanchnic anesthesia, however, I have used in 28 cases, but believe it to be less reliable and no safer than subdural block. For the past 6 years I have used spinal anesthesia routinely, supplementing with either gas and ether, or ether alone, for closure. In my opinion regional anesthesia prevents surgical shock, produces more complete relaxation, and reduces to a minimum the postoperative complications of vomiting, gastric dilatation, intestinal distention, and pneumonia.

The patient is placed on the operating table in the prone position, and the operative field is prepared in the usual manner. The incision begins at the ensiform cartilage and is continued downward to either the right or the left of the umbilicus, according to the situation of the ulcer. After the abdominal cavity is opened and the edges of the wound are protected with towels, a thorough exploration of the upper abdomen is performed. The ulcer is sought for in systematic fashion by careful search from the duodenum to the cardia. Identifying small ulcers on the posterior surface of the duodenum may offer great difficulties and unless unusual care is exercised, they may be overlooked. The most reliable method of detecting a posterior ulcer is palpation. These lesions will generally reveal their presence by an area of induration, part of which is represented by the raised indurated calloused edge of the ulcer.

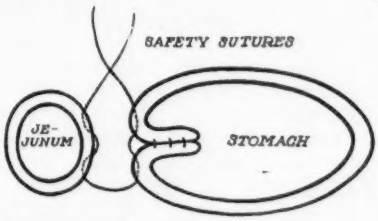

Fig. 9. Transverse incision through stomach and jejunum, demonstrating position of safety sutures (Finsterer).

Stippling of the peritoneum in the neighborhood of the pylorus is a most unreliable sign, as even a slight trauma, such as is necessary in visualizing this portion of the alimentary tract, may produce a similar effect. If the ulcer cannot be palpated, an attempt should be made to visualize it by transduodenal or transgastric inspection. This step can be greatly facilitated by the insertion of an ordinary urethral endoscope or a Cameron light into the suspected area. The finding of one ulcer does not end the search, as there may be multiple ulcers, one of which may be situated in the duodenum, the other on the lesser curvature of the stomach. An enlarged lymph node will frequently reveal the hiding place of a gastric ulcer. When resection is decided upon, the operation proceeds according to the situation of the ulcer. I shall describe the procedure for duodenal ulcer, as the steps of this operation are the same as in gastric ulcer except that those steps which apply particularly to duodenal ulcer are omitted.

With the left hand the transverse colon and omentum are withdrawn from the abdomen and made taut. The first portion of the jejunum, as it emerges from under the root of the mesentery at Treitz's ligament, is identified. About 6 to 10 centimeters from Treitz's ligament, a silk suture is passed through the wall of the jejunum, marking its proximal end. To the left of the spinal column, an avascular area is sought in the transverse mesocolon, through which a longitudinal incision 5 to 6 centimeters in length is made. The edges of this are secured with silk sutures for future identification. The suture marking the proximal end of the jejunum is now insinuated through the opening in the mesocolon and secured with a hemostat. This step makes the jejunal loop, which is to be anastamosed to the stomach, available without the necessity of searching for it after the stomach has been opened.

After the stomach has been made tense by an assistant, the index finger of the right hand of the operator is pushed through the middle of the les-

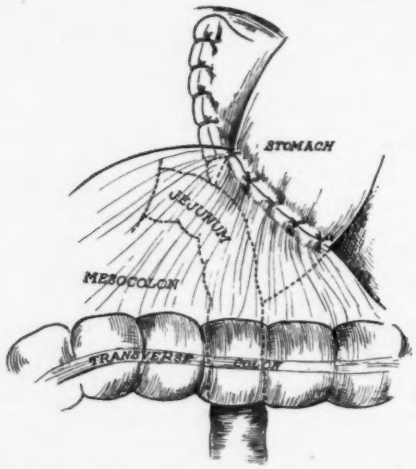

Fig. 10. Fixation right flap of mesocolon over anastomosis.

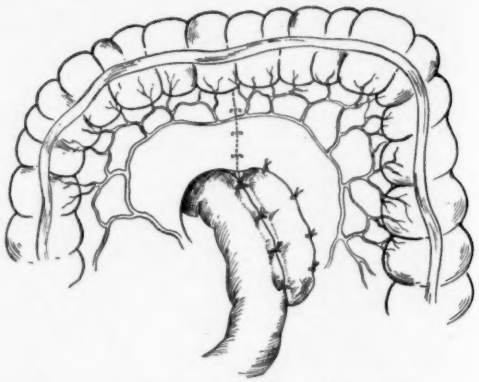

Fig. 11. Position of anastomosis below mesocolon.

ser omentum. Proceeding first to the left and then to the right, the lesser omentum is severed between double ligatures without an attempt being made to isolate the gastric arteries. Generally three to four ligatures are sufficient. The extreme left portion of the omentum, roughly corresponding to one-fourth of the stomach, is not severed, as this portion of the omentum is necessary to furnish blood for the remaining part of the stomach. On the right side, the severing of the omentum continues to the pylorus where it is discontinued, to be resumed later. With the gloved hand the posterior layer of the mesocolon, which embraces the mid-colic artery, is pushed from the posterior surface of the stomach, and the index finger is pushed through the greater omentum close to the greater curvature. The greater omentum is severed between double ligatures to the same extent as the lesser omentum. It is preferable to place these ligatures within the arterial arcade. Even though the mid-colic artery has apparently been pushed away, care should be taken that it is not accidentally ligated and severed. This artery may be difficult to identify and, if doubt exists as to its identity, the transverse colon should be inspected for blanching before cutting the omentum at that particular point. The stomach is now freed of its ligaments and ready to be resected.

The point at which the stomach is to be severed depends upon the desires of the individual operator; at all events the entire pyloric antrum must be removed, otherwise the much desired reduction in the gastric acidity will not occur. My own preference is to remove at least three-quarters of the stomach. The omental bursa is now protected by moist tapes and a straight intestinal clamp, placed at right angles to the body axis, is put across the stomach at the point elected for resection. A Payr's crushing clamp is placed in similar fashion 3 centimeters to the right. The stomach is then divided between these two clamps with the high frequency current. Severing the stomach at right angles to the body axis places the future stoma in the most advantageous position for complete and rapid emptying. It also prevents regurgitation from the afferent jejunal loop. The two severed ends of the stomach are now protected with gauze sponges. At this point many operators prefer to complete the gastrojejunostomy in order that the operation may be interrupted should it become necessary. This I believe to be a superfluous precaution as I have never found it necessary to complete the operation in two stages. On the other hand the primary dissection of the duodenum permits the operator to make use of the relaxation afforded by the subdural block, before it wears off, while the gastrojejunostomy can be painlessly and expeditiously performed without the aid of an anesthetic. The distal portion of the severed stomach is held in the operator's left hand and turned over to the right. By employing light traction the unsevered ligaments of the duodenum and the pancreas with its peritoneal covering are brought into view. This step, first suggested by A. A. Berg, greatly facilitates the subsequent dissection. Next the duodenal ligaments are severed between double ligatures to a point about 1 to 1.5 centimeters beyond the ulcer. In separating the ligaments on the superior border of the duodenum, care must be exercised not to injure the

bile ducts. This step frees the portion of the duodenum which is to be removed, except for its attachment to the pancreas. This attachment is released by a transverse incision of the peritoneal reflection between the duodenum and pancreas and, partly by sharp and partly by blunt dissection, the pancreas is dissected back beyond the point where the duodenum is to be severed. During the dissection the gastroduodenal artery as it traverses across the pancreas may be met and must be ligated, also the numerous small pancreatic duodenal arteries and veins will require double ligation. At the elected point, the duodenum is severed between two Payr's clamps by means of the high frequency current. The distal clamp remains in position temporarily, and all protruding portions of the duodenum are seared away flush with the clamp. The duodenum is closed as follows. The handle of the Payr's clamp is held in the left hand. Two or 3 millimeters below the crushing forceps on the posterior surface of the duodenum, at the border nearest the operator, a needle armed with No. 2 chromic catgut is inserted in an upward direction to the depth of the submucosa, emerging immediately below the clamp. The needle is crossed over to the opposite side of the duodenum and a similar stitch in a horizontal direction is placed adjacent to the clamp. These horizontal stitches crossing from one side of the duodenum to the other are continued until the opposite border of the duodenum has been reached. The last stitch is placed on the anterior surface of the duodenum, in similar manner to the first stitch except that the needle enters immediately below the clamp and emerges 2 or 3 millimeters farther down. The two free ends of the suture are then grasped by the operator in either hand, continuous traction being made, while the first assistant withdraws the clamp from beneath the suture line. This maneuver closes the duodenum and at the same time inverts the edges. By means of the same suture, a continuous Lembert suture, beginning at the border where the first suture was completed, is inserted, inverting the first suture line. A third row of interrupted silk Lembert sutures is placed above this. Finally the sutured end of the duodenum is covered by a layer of fatty tissue taken from the immediate vicinity.

The steps for closing the duodenum have been described in minute detail in order to impress my readers with the importance of this part of the operation. Its greatest danger lurks in the closed blind end of the duodenum. For, if leakage occurs at this point, not only may the entire purpose of the operation be defeated, but the outcome may be fatal. Many other ways for closing the duodenum have been described, but after thorough trial of these methods, I believe the one which I have described to be the simplest, best, and safest. The upper half of the open proximal end of the stomach is now closed in two layers, the inner layer consisting of a hemostatic suture with Dulox, the outer layer of interrupted silk Lembert sutures. The marker on the left border of the incision into the mesocolon is then located and this portion of the mesocolon is sutured by means of a few interrupted sutures to the posterior surface of the stomach close to its cut edge. Next the marker on the proximal end of the jejunum is sought and the jejunum is anastomosed to the lower unsutured end of the stomach in such fashion that the proximal end of the jejunum is directed toward the lesser curvature of the stomach. This anastomosis is performed in two layers in one of the usual ways of performing gastro-enterostomy. After this the proximal end of the jejunum is attached by means of several mattress sutures to the superior portion of the stomach which was previously closed. This step prevents kinking of the jejunum and protects the suture for closing the stomach at its most dangerous point. The right border of the incision in the mesocolon, upon which a marker has been placed, is sutured to the anterior surface of the stomach completely covering the anastomosis. This brings the stoma submesenteric and protects the omental bursa from infection in the case of leakage. Finally the abdomen is closed without drainage according to the preference of the operator. When the ulcer has perforated into the pancreas, it frequently becomes necessary to permit the base of the ulcer to remain and then to insert a drain to this point.

The postoperative treatment is most important and must be carried out with painstaking care. There is considerable difference of opinion concerning the after-care. Without entering into a discussion of methods employed by others, I shall briefly describe the method which I employ. It has served me exceptionally well and I have no hesitancy in recommending it. Immediately after the patient is returned to his bed, he is placed in the shock position. As soon as possible he is changed to a semi-sitting position and remains so during the entire convalescence. For 5 days nothing is given by mouth. During this time he receives daily by continuous venoclysis, about 3,000 cubic centimeters of 2.5 per cent glucose in normal saline. He is frequently turned from one side to the other. Under the direction of the nurse, he is made to take ten to twelve deep breaths every hour. If he has a chronic bronchitis, he is

encouraged to cough and not to suppress it. In my opinion these simple precautions go far to prevent pulmonary complications. On the fifth day, water in ounce doses is administered. The amount is gradually increased so that on the seventh day the patient receives fluids *ad libitum*. He is then given such foods as custards, junket, and ice cream. On about the eighth or ninth day pureed vegetables are added, followed by scraped beef, broiled meats, etc. On the twelfth to fourteenth day, the patient receives the general hospital diet and generally at the end of 3 weeks he is discharged from the hospital with no restrictions whatever upon his food. Rarely is it necessary to administer morphine, as these patients seldom complain of pain. If gastric distention occurs, drainage is instituted by a Levine tube. Usually or almost always the convalescence is very smooth and in many instances the postoperative course is no more turbulent than that of an appendectomy for chronic appendicitis.

In conclusion I wish to point out that this operation has been a source of utmost gratification to me for there are no more grateful patients than those who for years had been compelled to diet and then suddenly find themselves with a new lease on life, able to eat anything and everything without the slightest discomfort. Each addition to the menu brings them increased happiness. They are like children with new toys. I might also add that, since I have given up gastro-enterostomy, I no longer hesitate to enter the medical wards with the fear that one of my ulcer failures has come back to plague me.

I wish to express my gratitude to my surgical resident, Dr. Elmer Gooel, for many valuable suggestions in the postoperative treatment.

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PRE-OPERATIVE IODINE THERAPY IN HYPERTHYROIDISM[1]

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THE value of iodine as a therapeutic agent in the treatment of thyroid affections has been known for many centuries. As early as 1170 Rogers (3) at the University of Salerno, Italy, prescribed ashes of sponge and seaweed for goiter. In 1752, Russell demonstrated the value of sea water in relieving goiter. Coindet in 1820 was the first to show the value of the element iodine in thyroid disorders. In treating 100 cases which occurred in Switzerland he claimed to have cured or greatly improved two-thirds of his cases. In 1850, Chatin carried out extensive investigations on the iodine content of various foods and waters and presented evidence that iodine would prevent endemic goiter and cretinism. Trousseau, in 1868, made the historically famous mistake of prescribing tincture of iodine when he intended to give tincture of digitalis in a case of exophthalmic goiter. A prompt amelioration of all the toxic manifestations followed but he thought this to be the exception and not the rule and cautioned that iodine generally does harm in Graves' disease. This was followed in 1904 and 1911, by the work of Kocher who noted untoward effects of iodine in certain cases. Because of the wide influence of Kocher, his subsequent word of caution became almost a condemnation, and for years the use of iodine in the treatment of thyroid affections fell into disrepute.

The priority of calling attention in America to the value of iodine in the treatment of exophthalmic goiter belongs to Plummer. By carefully studying a large group of cases that had been benefited by the use of iodine as a pre-operative measure, Plummer placed its use in this disorder on a clinical basis. The theoretical rational underlying this administration of iodine was that in exophthalmic goiter a dysthyroidism was present due to the production of an incompletely iodized thyroxin molecule. To this incomplete product was attributed the power of entering into catabolic reactions faster than the normal, stable thyroxin molecule. In changing the thyroxin molecule by adding the deficient iodine there occurred a lowering of the basal metabolic rate and improvement in the toxic manifestations. In contrast to the exophthalmic type the so called toxic-adenomatous type was believed to be a hyperthyroidism due to an overproduction of the normal thyroxin molecule. Immediately following this work, numerous reports appeared in the American literature advocating the use of iodine as a pre-operative preparatory measure. Due to the influence of Plummer these reports were singular in that they all advocated the pre-operative administration in the exophthalmic goiter and decried its use in the adenomatous thyroid. In connection with the latter it was popularly believed that the administration of iodine might render the non-toxic ones toxic and aggravate the symptoms of the toxic adenomas. The incorrectness of this concept was soon revealed in the reports of Graham, Starr, and Youmans and Kampmeier. These authors demonstrated the similarity of response to iodine in both adenomatous and non-adenomatous goiters; and suggested that the exophthalmic goiter and toxic adenoma were but clinical variations of a single morbid disease. Subsequently contradictory reports from various sources appeared in the literature. At present, however, with the increasing literature (1, 2, 4, 5, 6, 7, 12, 13), there is a growing conception that only one type of hyperthyroidism exists, and that typical remissions with iodine in the majority of instances can be obtained in the nodular group as well as in the exophthalmic type.

GENERAL CONSIDERATIONS

The purpose of this study was to determine the relative efficaciousness of pre-operative iodine therapy in hyperthyroidism associated with primary hyperplasia of the thyroid as compared to the hyperplastic glands containing nodules, the so called toxic adenomas.

To add uniformity, 200 selected cases were chosen for this study. Cases that had received previous iodine medication, X-ray or radium therapy, or that had had previous surgical intervention (polar ligations, hemi-thyroidectomy or subtotal thyroidectomy) were not included in this series. Borderline cases, or cases presenting a question in diagnosis, were excluded. Age, sex, intensity, or duration of symptoms played no rôle in the selection of cases.

Since metabolic rate readings were to form a basic part of the study, only those patients having satisfactory metabolic rate determinations were chosen[2]. After a satisfactory pre-iodine basal rate was obtained the preparation for operation was

[2]Almost all of the metabolic rate determinations were made in Dr. Richter's office.

[1]From the surgical service of Dr. H. M. Richter, Passavant Memorial Hospital and from the Department of Surgery, Northwestern University Medical School.

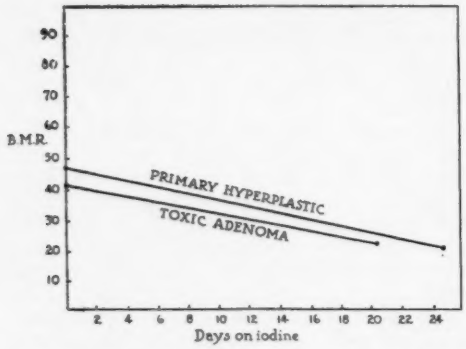

Chart 1. Average declivity of basal metabolic rate curves in each group.

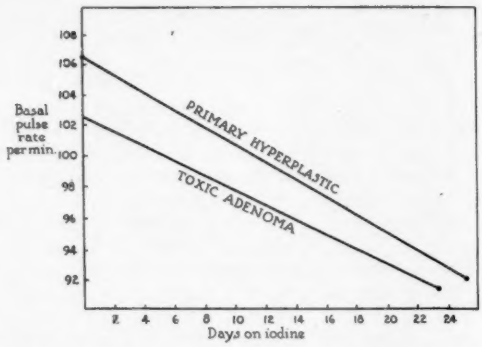

Chart 2. Average declivity of pulse rate curves in each group.

begun by administering iodine as Lugol's solution. This was given in doses of 30 or 45 minims (2. or 3. c.cm.) daily, for 10 to 20 days. In severe cases or occasionally because of social or economic conditions, it was necessary to continue the preoperative administration over a longer period of time. In the primary hyperplastic group the longest period of preliminary medication was 55 days in contrast to the shortest period of 9 days. The average was 25.3 days. In the secondarily toxic (adenomatous) group, the longest period was 58 days, the shortest period 6 days or an average of 23.3 days. The remainder of this study was occupied in noting the comparative slowing of the pulse and gains in weight in each group.

BASAL METABOLIC RATES

The primary hyperplastic group consisted of 100 cases. The highest pre-iodine metabolic reading was +97, the lowest +22, or an average of +46.12 for the group. The maximum decrease on iodine medication was 79 per cent. Three cases proved to be iodine resistant and showed an average increase in the basal rate of 16.3 per cent. In this connection it is interesting to note that even though these cases showed an increase in their basal rates, they gained in weight and were much improved by the preliminary medication. The average lowest post-iodine rate was +20.91. The average reduction in the basal metabolic rate for the group was 25.21 per cent.

The group of toxic adenomata also consisted of 100 cases. The highest pre-iodine metabolic determination in this group was +92, the lowest +19, or an average of +41.24. The maximum decrease was 37 per cent. Three cases were iodine resistant showing an average increase of 7 per cent. These cases also showed clinical improvement and two of them gained in weight. The average lowest post-iodine rate was +23.78. The average reduction for the group was 17.46 per cent.

From the foregoing, one is immediately impressed with the similarity of response to iodine in both groups. This is graphically and more strikingly illustrated in Chart 1 which shows the average parallel declivity of the curves for each group.

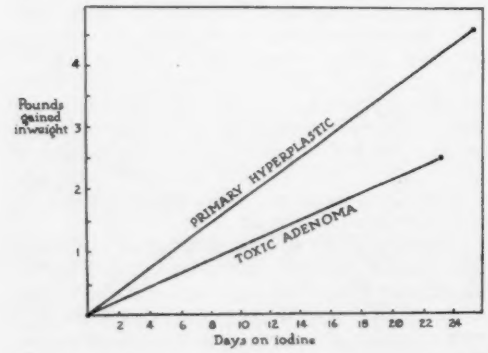

Chart 3. Average ascension of weight curves in each group.

CHANGES IN PULSE AND WEIGHT

Similar changes were noted in the basal pulse rates. In the exophthalmic type the highest preiodine pulse was 143, the lowest 82, or an average of 106.3 beats per minute. The most marked decrease in the pulse rate was 42 beats per minute occurring in one case after 25 days' medication. Twelve cases showed an average increase of 9.6 beats per minute and in 5 cases the rate remained

unchanged. The average diminution for the group was 14.5 beats per minute.

In the adenomatous type, the greatest rise was to 130, the lowest to 78, or an average rise to 102.6 beats per minute. In one case there was a decrease in the rate of 58 beats per minute after 21 days of Lugol's solution. Twelve cases showed an average increase of 10.6 beats per minute. In 4 cases the rate remained the same as before iodine was administered. The average decrease in rate for the group was 11.3 beats per minute. The above data reveals a marked similarity in response to iodine medication and is graphically illustrated in Chart 2.

The differences in weight in each group were also similar following pre-operative medication. The response though essentially the same in both the primary and secondary hyperplastic types, did not show the striking parallelism noted in the declivity of the pulse and basal metabolic rate curves. In the exophthalmic type the most marked individual gain in weight was 17 pounds, the greatest individual loss 5 pounds. Nine cases lost an average of 2.3 pounds. In 5 of the cases the weight remained unchanged. The average gain in weight for the group was 4.56 pounds.

In the adenomatous type, the maximum individual gain was 18 pounds, the maximum individual loss 14 pounds. In 16 cases there was an average loss of 3.4 pounds, and in 7 cases there was no change. The average increase in weight for the adenomatous type was 2.63 pounds. The comparative increase in weight for both types is illustrated in Chart 3.

In both types of cases there was a striking general clinical improvement. After the preliminary iodine medication, patients were less nervous and irritable. They were either troubled less with heart consciousness or entirely relieved of this symptom. In many cases their appetites improved and sleep was more restful. Three cases of the adenomatous type and 1 case of the exophthalmic type failed to notice any amelioration of symptoms after preliminary iodine medication.

SUMMARY

The response to pre-operative iodine medication was reviewed in 200 selected cases of exophthalmic and toxic adenomatous goiters. The object was to study the comparative lowering of the basal metabolic rate, slowing of the pulse, and increase in weight, in each type of hyperplasia. An almost parallel response was noted in the lowering of the basal metabolic and pulse rates. The average ascension of the weight curves also showed a very similar response but the parallelism was not nearly so marked as in the declivity of the basal metabolism and pulse rate curves. This favorable response, however, was not uniform in either group. In each type, cases were noted in which the administration of iodine did not effect a depression of the basal metabolic rate, lower the pulse, or result in an increase in weight. All of the above data is therefore interpreted as signifying that the factors operating in producing hyperthyroidism is the same in both the primary (exophthalmic) and secondary (adenomatous) types of hyperplasia.

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DUODENAL ULCER, SURGICAL TREATMENT

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A REVIEW of the development of the surgical treatment of *non-resectable* duodenal ulcer and a consideration of results may, perhaps, aid in establishing basic principles in the treatment of *resectable* duodenal ulcer.

Enterostomy which is done distal to the ulcer —jejunostomy—has not met with general acceptance.

Gastro-enterostomy (Fig. 1) has been a favorite method, but as remote results and after effects of the resultant abnormal physiology have been more carefully analyzed, a definite decline in its popularity has occurred.

Pyloric exclusion (Fig. 2) was presented by Eiselsberg as an improvement upon gastro-enterostomy. This procedure was followed by such a high percentage of stomal or jejunal ulcers, however, that it has been uniformly abandoned.

The next step in the pyloric exclusion operation included resection of parts of the stomach.

Haberer at first, in addition to the exclusion operation, removed the pylorus and the antrum (Fig. 3). This method was not satisfactory so he improved his technique by doing besides the antropylorectomy, a circumferential removal of the proximal, fundal, or acid secreting stomach wall (Fig. 4).

Finsterer removed the proximal, or fundal, stomach (Fig. 5), but allowed the distal stomach, antrum, and pylorus to remain.

The particular manner in which the gastro-intestinal continuity is re-established may or may not be an important detail when compared with the fundamental principles of the operation.

Of the various modifications of the Billroth I and II, the Hofmeister-Finsterer, terminolateral anastomosis that aims to prevent retrograde filling of the duodenal stump seems to be meeting with favor (Fig. 6).

The difference between the procedures of Haberer and of Finsterer is primarily in the removal (Haberer) and in the retention (Finsterer) of the antrum and pylorus.

Haberer and his followers deem it essential that the pylorus and the antrum be removed, because the secretion of the antrum is supposed to act as an important stimulant to the acid secreting cells located in the fundus. Edkins, years ago, promulgated such a theory, but it has not been accepted in various physiological laboratories and in the clinics of many surgeons.

Finsterer and his followers, on the other hand, allow the antrum and pylorus to remain, claiming their removal is unimportant. Finsterer and

Fig. 1.

Fig. 2.

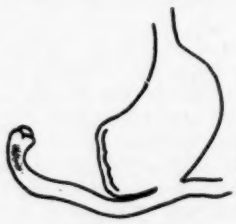

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Figs. 1 to 8 show the development of the surgical treatment of non-resectable duodenal ulcer.

Fig. 1. Gastro-enterostomy.

Fig. 2. Gastro-enterostomy, plus exclusion (Eiselsberg).

Fig. 3. Gastro-enterostomy, plus resection of pylorus and antrum (Haberer).

Fig. 4. Gastro-enterostomy, plus resection of pylorus and antrum plus resection of part of proximal stomach,—partial or subtotal gastrectomy (Haberer).

Fig. 5. Gastro-enterostomy, plus resection of part of proximal stomach, but with retention of distal stomach (Finsterer).

Fig. 6. Same as 5; but with Hofmeister-Finsterer modification of Billroth II gastro-enterostomy. (The many other modifications are not shown.)

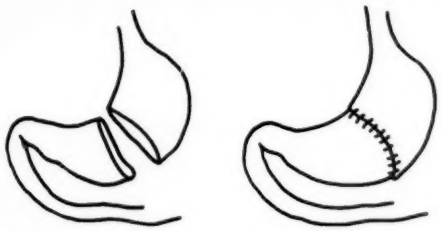

Fig. 7. Sleeve resection is unsatisfactory.

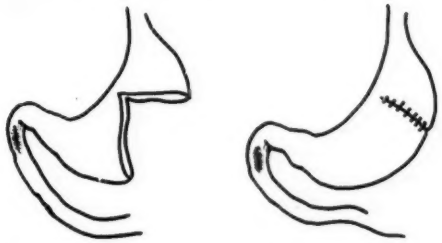

Fig. 8. Partial fundusectomy preserves the direct motor continuity and diminishes the acid secreting area.

Haberer agree upon the necessity of "adequate" removal of the acid secreting, proximal, fundal, stomach wall (only the cardiac third remaining).

And such a conclusion would seem to be supported by the increasing frequency of stomal or jejunal ulcers after gastrojejunostomy, and of the "intractable" cases in which recovery has not been achieved until two or three resections, for repeated recurrences, have removed most of the acid secreting fundus. Such instances cause a surmise as to the result if the wide, or "adequate" fundal resection had been made at the first, instead of the last, operation.

A review of these different operations and their underlying principles suggests the question: If, in *non-resectable* duodenal ulcer, gastro-enterostomy, pyloric exclusion (Eiselsberg) and exclusion with resection of pylorus and antrum (Haberer) are not satisfactory, and, if exclusion with resection of pylorus and antrum and also circumferential resection of part of the fundus (Haberer) is more satisfactory, and if exclusion with circumferential resection of part of the fundus but *without* resection of pylorus and antrum (Finsterer) is equally satisfactory, why remove the pylorus and antrum in resectable duodenal ulcer?

The logical answer would seem to be that if removal of the antrum and pylorus is unnecessary in advanced, complicated, so called non-resectable ulcer, then their retention with removal of the fundus (with or without local excision of the ulcer) would be worthy of a trial in the earlier, simpler, more common resectable ulcer.

The next question would logically be: Can the resection of the fundus with retention of the antropylorus (Figs. 5 and 6) be improved so as to preserve direct motor continuity? Sleeve resection (Fig. 7) has been unsatisfactory. "Partial fundusectomy" (Fig. 8) does preserve the direct motor continuity and the important antropyloroduodenoneuromuscular mechanism and diminishes the acid secreting area.

With organic pyloric obstruction an additional plastic operation would be indicated. Without organic pyloric obstruction the ulcer might, or might not, be removed. In either event operation should be followed by postoperative "medical management."

There are indications that hydrochloric acid is not the sole cause of peptic ulcer, but it is becoming recognized as a very important and constant factor among the fifty or more different explanations for the *chronicity* of the disease.

The stomach seems to be a modified double organ; the proximal (fundus), concerned with acid secretion; and the distal (antrum-pylorus), having to do with alkali secretion and motor regulation. Peptic ulcer is now considered as a physiological problem in which there is a lack of balance between an aggressive (acid) and a defensive (alkaline) factor.

All of which calls for a reconsideration of so called "radical treatment," that is called radical because of the removal of the ulcer, alone, with the pylorus, or with the "ulcer-bearing area." Such measures might be considered as "symptomatic," and the classification "radical" might be reserved for those methods in which an attempt is made to influence a supposed cause, or an important causative factor, such as hydrochloric acid.

Treatment, heretofore, has been aimed chiefly at an increase in the defensive or protective forces: by use of diets, antispasmodics, alkalis, demulcents, protein shock, operations, etc., etc. The newer methods attempt to diminish the aggressive element by anti-secretagogues or by surgical minimization of acid secreting surfaces.

There is a growing acceptance of the clinical fact that peptic ulcer is a general disease with a local lesion; that simple excision of the ulcer does not necessarily cure the disease; and that operative and non-operative measures should be not antagonistic but complemental.

ORTHOPEDIC CONSIDERATIONS IN THE TREATMENT OF SPINA BIFIDA

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THE operative treatment of frank spina bifida in the newborn is of considerable interest to the neurological surgeon, and in recent years clinical reports on this subject have frequently appeared in the literature. Analyses of end-results by Cutler, Coughlin, Penfield and Cone, Kolodny, and Gross and Sachs have emphasized the life saving nature of early plastic repair of meningocele and myelomeningocele in this condition. Paralyses and deformities of the lower extremities which have been present before operative treatment are, however, not usually benefited by this procedure, and remain to be cared for by orthopedic methods. Flaccid and spastic muscle paralyses, deformed bones and joints, and more or less serious sensory, trophic, and circulatory disturbances go to make up the sum of the orthopedic surgeon's problems. Urinary and fecal incontinence, with a predisposition to urinary tract infection, is also frequently found in these cases and constitutes a complicating factor in their treatment.

Similar problems are presented to the orthopedic surgeon in a somewhat larger group of cases in which deformities are found in association with an occult spina bifida. While it has been established that incomplete fusion of the laminæ of the lumbar and sacral vertebræ is normally very common in early childhood (Hintze, Steindler, Neubert), the pathological significance of the persistence of these defects, in some cases showing incontinence of bladder and rectum or neuromuscular disturbances in the lower extremities, seems quite certain. In the clinical reports of Katzenstein, Cramer, Brechot, Colby, and others, pressure or traction upon the spinal cord and cauda equina, produced by fibrous bands and myofibrolipomas in association with vertebral clefts, has produced a variety of disabilities. On the other hand, the studies of Fuchs indicate that a primary defect in development of the central nervous system, a myelodysplasia, may be associated with a persistent lumbosacral spina bifida occulta and give rise to congenital deformities of the lower extremities. Deformities of the feet are found frequently in childhood in conjunction with extensive defects in the laminæ of the lumbar and sacral vertebræ, and clinically these malformations are distinct from other congenital types. Congenital dislocations of the hip and spinal curvatures also frequently accompany vertebral defects, but the etiological relationship of the bifid spine to these deformities is not clear. Urinary and fecal incontinence may be found in association with spina bifida occulta just as in cases of frank spina bifida with cystic myelocele, in which the nerve involvement is more obvious.

A series of 90 cases of spina bifida treated at the Shriners' Hospital of St. Louis, Missouri, from 1924 to 1935, has here been analyzed to define some of the variations in the clinical picture of this condition to be found in childhood, and to evaluate the results obtained by standard orthopedic methods in the management of the problems which the condition presents. Of the 90 cases studied, 15 were cases of spina bifida with an associated herniation of the structures of the spinal canal upon which an early plastic operation had been done. The 75 other cases were to be classed as spina bifida occulta. Of this latter group, 39 showed defects in the spine in the lumbosacral region which were entirely lacking in signs and symptoms, and were discovered by X-ray examination during the course of treatment for other conditions.

Marked deformities and disabilities were characteristic of the group of cases of spina bifida with which a definite meningeal sac had been associated. All of these cases showed deformities of the feet, and these deformities were quite lacking in uniformity. While the most common position of deformity was equinovarus, almost every other type of malformation was represented: equinovalgus, equinovarus with cavus, calcaneovarus, calcaneovalgus, and simple equinus, calcaneus, cavus, varus, and valgus. Frequently the deformities of the two feet were entirely different. In 4 cases, a bilateral dislocation of the hip was found. In 8 cases there was incontinence of urine and feces; 2 were incontinent of urine only. In 6 cases a tendency to hydrocephalus, was shown, one patient being of subnormal mentality. Eight showed diminution of sensation in the lower extremities; in 3 there was definite disturbance of circulation in the legs; in 4 cases trophic ulcers of buttocks and feet were noted. One patient admitted to the hospital for reconstructive work upon the feet was found to have a bilateral

hydronephrosis with hydro-ureter, and this patient died later of pyelonephritis. Of interest in this case are the studies of Mertz and Smith, who have found that defects of the lumbosacral spine are associated not infrequently with paralysis of the vesical sphincter and obstructive dilatation of the upper urinary tract.

Of a group of 36 patients showing deformities in association with a spina bifida occulta, 18 had malformations of the feet of various kinds. Five patients showed congenital hip dislocations in addition to their deformed feet. Nine other cases were found with congenital hip dislocations, unassociated with other deformities. There were 7 cases of scoliosis: 3 with a dorsal curvature, 4 with a double curve in the dorsolumbar region. Four patients showed an incontinence of urine and feces; 2 were incontinent of urine only. One of these patients, having an incomplete fusion of the sacral vertebræ, developed incontinence of bladder and rectum following an injury to his back at 11 years of age. Three other cases are of more than ordinary interest: a congenital malformation of the ear associated with a spina bifida of the cervical vertebræ, a congenital elevation of the scapula associated with a spina bifida involving the seventh cervical and first and second thoracic vertebræ, and a congenital absence of the neck of the femur associated with a lack of fusion of the first and second sacral segments of the spine. In the entire group of cases showing deformities in association with a spina bifida occulta, no correlation between the size of the spinal defect (as shown by X-ray) and the degree of the deformity or disability could be determined.

The treatment of the cases of spina bifida having from birth an obvious involvement of the central nervous system is summarized in Table I. In general, this treatment has consisted of the correction of deformities of the lower extremities by manipulations, wedging plasters, the lengthening and transplantation of tendons, and the arthrodesis of joints. Reduction of the four bilateral hip dislocations has not as yet been attempted. Three of these cases have practically no muscle power in the lower extremities and have never walked. In this group, wherever any degree of muscular strength existed in the lower extremities, orthopedic treatment improved the powers of locomotion. Leg braces were frequently employed to maintain the correction of deformities of partially paralyzed extremities; and crutches were required in a number of cases.

Cutler and Coughlin have emphasized the unfavorable prognosis in patients having incontinence of bladder and bowel, and the possibilities for relief of these individuals are few indeed. Coffey's uretero-enterostomy may possibly be applicable in cases of urinary incontinence alone; but this operation can be of no help in cases of incontinence of both sphincters. Transplantation of the gracilis muscle into the perineum to encircle the urethra may reinforce vesical sphincter action in selected cases of urinary incontinence (Deming, Player and Callander, Smith and Engel). Young's plastic operation upon the vesical sphincters may also be of use in certain instances. According to Smith and Engel, the existence of some sensation of bladder filling or emptying is prerequisite for a good result when operations to reinforce sphincter control are performed. In cases characterized by a marked urinary retention with overflow, presacral neurectomy, as described by Learmonth and Braasch, seems to be a promising procedure. While this operation was first introduced to genito-urinary surgery in the treatment of the cord bladder produced by a postnatal nerve injury (transverse myelitis), it has now been successfully applied for the relief of urinary incontinence associated with congenital spinal defects. C. B. Huggins of the University of Chicago has observed improvement in 4 of 5 incontinent spina bifida cases subjected to presacral neurectomy,[1] and Craig has reported a favorable result of the operation in the treatment of a case of urinary incontinence associated with a spina bifida occulta. It should be noted that the experimental work of McCrae and MacDonald has indicated that the physiological basis for presacral neurectomy is in need of further investigation. Reports thus far of the clinical results of presacral neurectomy are encouraging, however, and the operation would seem to be destined for a more extensive use in cases of spina bifida with incontinence.

The problems involved in the handling of a case of spina bifida with marked nerve damage are illustrated by the following case (see Figs. 1, 2, and 3):

G 85, M., 9 years. Lumbosacral meningocele was present at birth. Plastic operations for the correction of this condition were performed after 12 hours. The head increased in size abnormally during the first 3 months of life. Plaster casts were applied for correction of deformities of feet at 1 year. At 2 years of age, patient was seen at Shriners' Hospital for the first time. On this occasion he showed a marked paralysis involving the lower extremities, hypesthesia of the lower extremities, bilateral dislocation of the hip, bilateral club feet, and incontinence of bladder and rectum. The mentality was normal.

Roentgenograms showed spina bifida involving the third, fourth, and fifth lumbar and all sacral vertebræ.

[1]Personal communication.

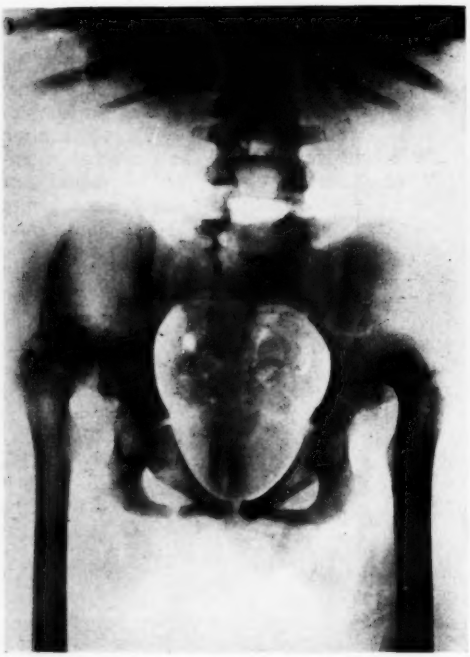

Fig. 1. Roentgenogram of Case G 85 showing laminal defects of third, fourth, and fifth lumbar, and all sacral vertebræ.

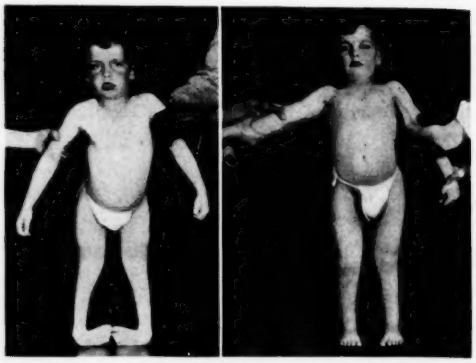

Fig. 2, left. Case G 85 before operative treatment.
Fig. 3. Case G 85 after bilateral astragalectomy, and bilateral arthrodesis of the ankle joint.

Treatment: In 1927, manipulations of the feet with fixation in plaster were done. In 1930, the right foot was manipulated under anesthesia, and a subcutaneous tenotomy of anterior tibial tendon was done. Wedging plasters were tried, but were discontinued when pressure sores developed. Right astragalectomy was carried out with lengthening of the heel cord. Left astragalectomy was done. Deformities of feet were corrected by these operations. In 1933, patient was admitted, showing no motion in ankles but considerable equinovarus deformity. Arthrodesis of both ankles was performed.

Patient walked on crutches fairly well 1 year after bilateral ankle arthrodesis, but still requires treatment for hip dislocations.

Spina bifida occulta has long been considered to be a significant finding in certain neuromuscular affections of the lower extremity and in certain derangements of bladder and bowel action. Cases of urinary incontinence have been improved by laminectomy with the removal of fibrous bands from within the spinal canal (Katzenstein, Brechot, Jacobovici, Urechia and Teposu, and Mertz); and deformities of the feet, and sensory and trophic disturbances usually appearing or becoming more marked in early adult life, have been benefited by the removal of tumor masses compromising the spinal cord or cauda equina (Jones, Sever, Brickner, Hackenbroch, Kochs, DeVries). All explorations of spinal defects have not been successful, however. Indeed, Brickner, Hackenbroch, and Mertz have reported indifferent results in a considerable proportion of their cases. In patients not benefited by laminectomy, a primary defect in the spinal cord or an irreversible effect secondary to pressure has been assumed.

Various deformities of the feet have been described in association with spina bifida occulta. These are probably due, for the most part, to a muscular imbalance secondary to a congenital nerve defect. The club foot, claw foot, and flat foot are the more common of these deformities (Beck, Hackenbroch, Dittrich). It has been noted by Beck that deformities of the feet present from birth and associated with a persistent spinal cleft are more resistant to treatment than other congenital varieties. This resistance to treatment was certainly characteristic of the 18 cases of foot deformities considered in the present study (see Table II). Only 3 of these patients were treated with any degree of success by closed methods, and all the others required operative treatment, consisting in the main of arthrodeses of the tarsal joints and the lengthening and transplantation of tendons about the ankle. In a number of cases of this series, the presence of a spina bifida occulta was not discovered until the tendency of the deformities to recur suggested the advisability of an X-ray examination of the spine.

The marked resistance to treatment of the foot deformities associated with spina bifida occulta is best explained on the basis of the muscular

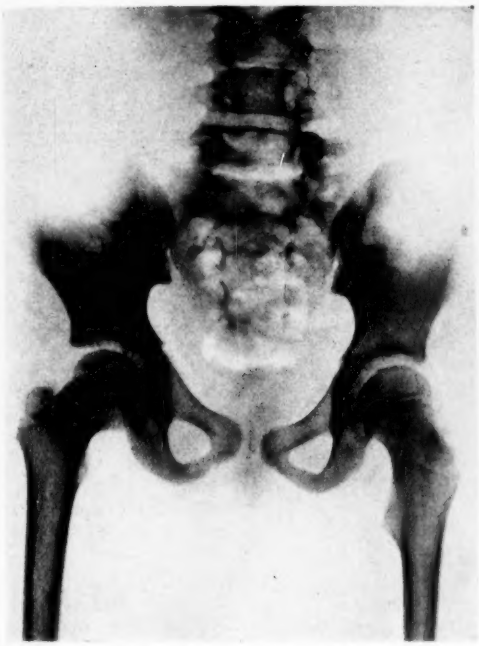

Fig. 4. Roentgenogram of Case H 139 showing laminal defects of third, fourth, and fifth lumbar, and all sacral vertebræ.

imbalance present in almost all cases. Stabilization of the foot, with shifting of tendons to balance more properly the forces acting upon the tarsus, constituted the plan of operative treatment which was most effective in the prevention of a recurrence of the old deformity.

The following case summaries illustrate the usual response of these patients to treatment:

H 139, F., 7 years (Figs. 4, 5, 6). Child was first seen at the age of 3. She gave a history of club foot, left, since birth. She was treated with plasters in infancy without success.

Examination revealed the foot in equinovarus, with some cavus; abnormally cold, and cyanotic. Reflexes of the left lower extremity were not obtained. Mild flexion deformity of left knee was noted.

Treatment: In 1931, a wedging cast was applied to the knee to correct the flexion deformity. Three manipulations of left foot were carried out under anesthesia. Complete overcorrection of the foot deformity was accomplished by the treatment, but a recurrence was noted within a year. In 1933, full overcorrection was obtained by wedging plasters. A pressure sore developed at the base of the metatarsals on the sole of the foot during this treatment, but healing was readily accomplished by the application of alcohol dressings. Patient was discharged home walking well, with an outside lift to her shoe. In 1934, examination revealed that the deformity had recurred within a year;

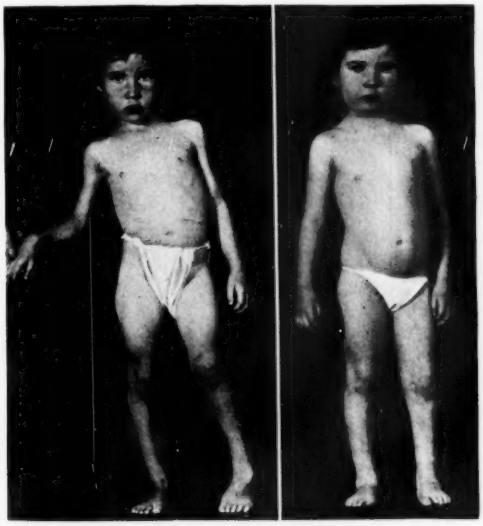

Fig. 5, left. Case H 139 before operative treatment.
Fig. 6. Case H 139 after lengthening of heel cord, triple arthrodesis, and tibial turn, left.

and on her third admission to the hospital, a spina bifida involving the third, fourth, and fifth lumbar, and all the sacral vertebræ was found by X-ray. At this time, lengthening of the left heel cord, with a triple arthrodesis, and osteotomy of the tibia, were performed. The foot was found to be maintained in good position 6 months after stabilization.

I 18, F., 3 years (Figs. 7, 8). History revealed presence of bilateral club foot since birth. No treatment had been given. Examination disclosed an equinovarus deformity on right; valgus deformity on left; dislocation of left hip. Over the spine in the lumbar region, was a pigmented mole, about 2½ centimeters in diameter. Sensation of both lower extremities was diminished. X-ray examination revealed a dislocation of the left hip; spina bifida of the third, fourth, and fifth lumbar vertebræ.

Treatment: In 1932, repeated manipulations of feet were carried out under anesthesia—lengthening of heel cord, left; section of peroneals, left; lengthening of anterior tibial, extensor digitorum communis, and peroneus tertius tendons, left. Chronic pyelitis complicated the hospital course at this time. In 1933, a wire was inserted through the lower left femur, and the head of the femur was pulled down opposite the acetabulum under 23 pounds of traction. Closed reduction of the dislocation was performed, followed by a supracondylar osteotomy. Open reduction of the hip dislocation became necessary later, when a redislocation occurred in walking. The hip was stable 2 years after operative procedures. The right foot was unstable, tending to turn into valgus in walking; left was held in fairly good position. Arthrodeses of tarsal joints of both feet are planned when child is older.

I 94, F., 2 years. Pes equinovarus, left, has been present from birth. The condition was treated with plasters during the first year of life, and later the foot was manipulated regularly by the mother. Deformity was improved by these measures, but some residual equinus and inversion remained.

Fig. 7. Case I 18 showing deformities of feet before treatment.

Fig. 8. Roentgenogram of Case I 18. Laminal defects of third, fourth, and fifth lumbar vertebræ. Dislocation of left hip has been reduced.

Treatment: In 1932, patient was admitted to the hospital. One manipulation under anesthesia, followed by a wedging plaster, seemed to correct the foot deformity very well. Patient wore a brace on the left foot for 8 months after this correction. A tendency to recur in the old deformity was noted, however, 4 months after the brace was discarded. An X-ray film at this time disclosed a spina bifida involving the fifth lumbar and first sacral vertebræ. The bony defects were of moderate size.

Examination 2½ years after patient's discharge from hospital showed the left foot to be very stiff with a tendency to inversion and adduction of the forefoot. There is one inch shortening of the left lower extremity, with a knock-knee deformity, and marked atrophy of the musculature below the knee. Stabilization of the foot, with an osteotomy of the tibia to correct the knock-knee, will be performed when the child is older.

On the whole, the local operative treatment of the foot deformities associated with spina bifida occulta at Shriners' Hospital has yielded satisfactory results. All cases considered in this study have not been followed to maturity to determine whether or not the operative correction of their deformities will be definitive. Cramer, Beck, and Hackenbroch have advocated exploratory laminectomy in cases of spina bifida occulta in which deformities recur in spite of local surgical treatment. It is possible that some of the cases reported here may show recurrences of their deformities later on, when, during the period of accelerated growth at puberty, the damaging effect of bands or tumor masses within the spinal canal may be accentuated. Deformities which are due to a primary defect of development of the central nervous system can reasonably be expected to remain corrected, however, as the individual develops to maturity. Laminectomy would seem to be a procedure to be reserved for cases showing recurrent deformity, progressive muscular paralysis, or increasing sensory and trophic disturbances.

The congenital dislocations of the hip associated with a spina bifida occulta have presented no special clinical features. The 14 cases studied were treated by closed or open methods, as indicated by the character of the dislocation and the age of the patient; and the results of treatment have been satisfactory. Beck has concluded that the assumption of a causal relationship between a spina bifida occulta and an associated congenital hip dislocation is not justifiable. It must be said that, from the evidence of this analysis, Beck's point of view cannot be controverted.

The 7 cases of scoliosis of this series, with spina bifida occulta occurring in association, may also be said to be indistinguishable in their clinical characteristics from other types of idiopathic curvatures. A causal relationship here between a

Fig. 9. Case J 87 showing lumbodorsal scoliosis.

spinal defect and a spinal curvature would seem plausible, but would be difficult to prove. In this group of cases, the vertebral defects were found from the cervical spine to the sacrum, with the curvatures being dorsal and dorsolumbar. There was no absolute regional agreement between the bifid vertebræ and the location of the scoliosis. The cases were treated satisfactorily by jacket support, spinal fusion being reserved for treatment in certain selected cases. Following is a typical case history of a patient of this group:

J 87, F., 5 years (Figs. 9, 10). Curvature of spine was first noted by mother 11 months previous to admission. There were no symptoms related to the spine. Treated by an osteopath with some benefit, according to mother.

Examination revealed no abnormality of gait. Patient walked with shoulders squarely over pelvis, with just a slight shift to the left. Curvature of spine to the left was noted in mid-dorsal region. No evidence of infantile paralysis. General physical examination was negative.

X-ray films revealed a left lumbosacral scoliosis, with the apex of the curve at the level of the eighth dorsal vertebra. Sacralization of fifth lumbar vertebra was noted. Spina bifida of fourth and fifth lumbar and all sacral vertebræ was present.

Patient was instructed regarding exercise, and was fitted with a wedging plaster jacket. Parents understand that a spinal fusion may be necessary, if conservative measures do not prevent further curvature.

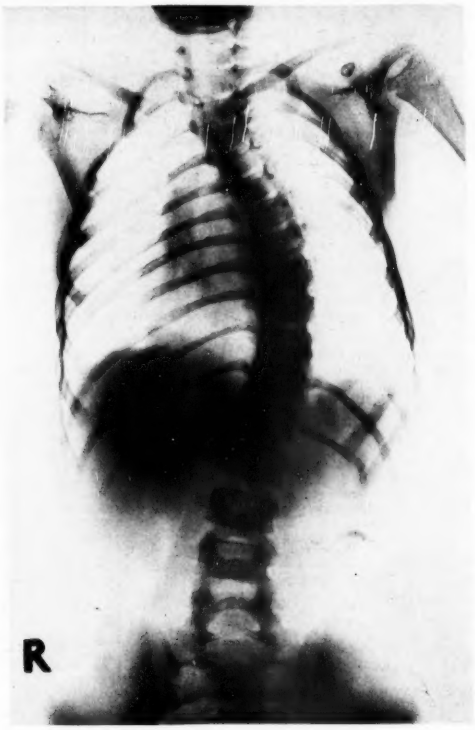

Fig. 10. Roentgenogram of Case J 87. Laminal defects of fourth and fifth lumbar, and all sacral vertebræ; sacralization of fifth lumbar vertebra.

The 6 cases of the present study showing dysfunction of the vesical sphincter in association with a spina bifida occulta have as yet received no treatment directed toward the relief of their incontinence. In this type of case, laminectomy offers a better than 50 per cent chance of improvement (Mertz). In the treatment of patients whose symptoms are not relieved by such causal intervention, presacral neurectomy, and other operative procedures directed more particularly toward the reinforcement of sphincter control, remain as possibilities.

SUMMARY

1. In this analysis is presented a summary of the orthopedic features of 15 cases of frank spina bifida in which patients have had a plastic operation upon the spinal defect early in life, and of 36 cases of spina bifida occulta found in association with deformities of the extremities and of the spine.

TABLE I.—CASES OF SPINA BIFIDA HAVING A CYSTIC TUMOR AT BIRTH

Patient Age Sex	Spinal defect	Deformities	Associated conditions	Treatment	Remarks
A 64 11 yr. F	Lumbosacral (Plastic operation on 3rd day)	Feet flail with contractures of hips and knees	Incontinent of urine; diminished sensation in lower extremities; trophic ulcers of feet and buttocks	Section of hip flexors Contractures corrected by manipulations	Contractures recurred within a year after discharge Patient incapable of walking Prognosis poor
G 85 9 yr. M	3, 4, 5 L. and all sacral vertebræ (Plastic operation after 12 hours)	Bilateral dislocation of hip Bilateral pes equinovarus	Incontinent of urine and feces; diminished sensation in lower extremities; trophic ulcers of feet	Manipulations of feet Wedging plasters Bilateral astragalectomy Bilateral arthrodesis of ankle joint	Feet in good position after 1 year. Walks with crutches Hip dislocations remain to be treated
G 118 3 mos. F	Lumbosacral (Plastic operation at 3 months)	Pes calcaneovarus, left Pes calcaneovalgus, right	Hydrocephalus Incontinent of urine and feces	Meningocele repaired Manipulations of feet Wedging plasters	Walking well at 4 years of age, except for tendency to invert feet; still incontinent; hydrocephalus not progressing
I 170 5 yr. M	Lumbosacral (Plastic operation at 14 weeks)	Bilateral pes calcaneovarus	Hydrocephalus Incontinent of urine and feces; diminished sensation below knees	Patient fitted with crutches and braces	Stabilization of feet, with transplant of anterior tibial tendon to mid-tarsus, to be done later
I 184 10 mos. M	Lumbosacral (Plastic operation early)	Bilateral pes varus	Hydrocephalus Diminished sensation below knees	Manipulation of feet under anesthesia Wedging plasters	Feet recurred in varus deformity within a year. Stabilization recommended for permanent correction
J 51 4 yr. F	Lumbosacral (Plastic operation at 2 months)	Pes equinovarus, right	Incontinent of urine and feces Ulcer of buttock	Wedging plasters Transplant of anterior tibial tendon to outer tarsus	Excellent correction of foot
J 150 12 yr. M	Lumbosacral (Plastic operation at 7 days)	Bilateral pes calcaneovalgus Contractures of hips and knees; flaccid paralysis below knees	Incontinent of urine Trophic ulcers of buttocks	Section of dorsiflexors of feet, with bilateral double arthrodesis	Excellent result
K 28 12 yr. M	Lumbosacral (Plastic operation at 3 years)	Bilateral claw foot	Incontinent of urine and feces	Previous to admission, Steindler stripping of the os calcis, bilateral After admission triple arthrodesis, plantar fasciotomy, and section of the posterior tibial tendon, bilateral	Good result after 8 months
K 181 7 yr. F	5L, 1S Meningocele present	Legs flail below knees Muscle power diminished around hips; dislocation of both hips	Hydrocephalus Subnormal mentality; incontinent of urine and feces; diminished sensation in lower extremities	No operative treatment indicated Parents advised to get child a walker	Prognosis poor
D 44 9 yr. F	All sacral vertebræ (Plastic operation in infancy)	Pes equinovarus, left Pes valgus, right, with tibial torsion	Bilateral hydronephrosis with hydroureter; feet cold, cyanotic, and hypesthetic	Patient admitted to hospital for stabilization of feet	Patient died of pyelonephritis before operative treatment could be carried out
L 3 4 yr F	2, 3, 4, 5L (Plastic operation at 4 years)	Pes equinovarus, marked	Hydrocephalus, slight	Repair of meningocele	Stabilization of foot to be carried out later
201 3 yr. M	5L, all S (Plastic operation at 12 days)	Bilateral pes calcaneus	Incontinent of urine and feces	No immediate operative treatment indicated in view of age of patient	Patient was not returned to the hospital
1241 4 yr. M	4, 5L (Plastic operation at 5 weeks)	Bilateral dislocation of hip; gluteal muscle weak, adductors of thighs contracted. Flaccid paralysis below knees	Incontinent of urine and feces Slight hydrocephalus. Feet cold, cyanotic, hypesthetic	Adduction of thighs corrected by exercises	Patient unable to walk Operative treatment deferred
2229 9 yr. M	Lumbosacral (Plastic operation at 3 months)	Bilateral hip dislocation Bilateral pes equinovarus Knees partially ankylosed in recurvatum	Hydrocephalus Incontinent of urine and feces	Patient fitted with crutches	No operative treatment indicated until child has learned to walk with crutches
2320 12 yr. M	Lumbosacral (Plastic operation at 3 months)	Pes valgus, right Pes equinovarus, left (mild)	Diminished sensation below knees; feet cold	Previously at 10 years of age, child had bilateral heel cord lengthening, with stabilization of right foot Restabilization of right foot recommended	Name on waiting list for operation

TABLE II.—CASES SHOWING FOOT DEFORMITIES IN ASSOCIATION WITH SPINA BIFIDA OCCULTA

Patient Age (years) Sex	Spinal defect	Examination	Treatment	Remarks
A 92 7 M	10D to 3L ++++	Fixed external rotation of hips, and bilateral pes equinovalgus (Hypesthesia of saddle area, feet and legs)	Osteotomy of femur, bilateral, with internal rotation of lower portion of shaft Thomas heels for valgus deformities of feet	Patient improved
A 171 12 M	10D to 1S +++	Dislocation of left hip Bilateral pes valgus	Closed reduction of hip dislocation Tenotomy of peroneal tendons, bilateral Double arthrodesis, left	Patient walking well, feet in good position, after 2 years
B 89 4 F	5L + Spondylo-listhesis	Bilateral pes equinovarus; contractures of knees and hips	Manipulations of feet Contractures corrected by traction and wedging plasters	Patient has never walked Incontinent of urine and feces Prognosis poor
B 199 14 F	1, 2S ++	Bilateral pes equinus	Bilateral lengthening of heel cord (Vulpius operation)	Excellent result
B 231 9 F	1, 2S ++	Bilateral pes valgus	Manipulation and fixation in plaster Bilateral lengthening of heel cords Double arthrodesis, right Flat foot operation, left.	Feet in good position after 1 year
D 130 7 M	All sacral vertebræ ++++	Dislocation of both hips Bilateral pes equinovarus	Closed reduction of hip dislocations Repeated manipulations of feet Tenotomy of Achilles tendons Double arthrodesis, bilateral	It was necessary to restabilize feet 2 years after bilateral double arthrodesis
F 188 7 F	5L, 1S ++	Dislocation of both hips; pes equinovarus, left; contracture of knee, left, with tibial torsion	Lengthening of heel cord, left. Open reduction of both hip dislocations. Subtrochanteric osteotomy, right. Arthrodesis of left hip. Triple arthrodesis, left. Osteotomy of tibia and fibula, left.	Hips stable, foot in good position, after 1 year
G 32 10 F	1, 2S +	Bilateral pes cavus (most marked on right)	Steindler stripping of os calcis, right Triple arthrodesis, right	Good result after 4 years
H 139 7 F	3, 4, 5L All sacral +++	Pes equinovarus with some cavus, left Flexion of knee, left (feet cold and cyanotic)	Manipulation and fixation of left foot in plaster Wedging cast to left knee Wedging plaster to foot Lengthening of heel cord, left Triple arthrodesis, left Osteotomy of left tibia for correction of torsion deformity	Foot in good position after 6 months
H 223 5 F	5L +	Bilateral pes equinovarus	Series of manipulations under anesthesia, supplemented by Kite wedging plasters	Good result after 2 years
I 77 9 F	5L to 3S +++	Bilateral pes equinovarus Flexion contractures of knees	Previous to admission: Stabilization of feet Osteotomy of femur, right After admission: Supracondylar osteotomy of femur, right Section of inner hamstrings, right Erasion of knee, right	After 2 years, bending noted at the lower right femoral epiphysis with recurrence of flexion deformity Patient fitted with a brace to support knee
I 94 2 F	5L, 1S +	Pes varus, left Shortening of left leg with genu valgum	Repeated manipulations Wedging plasters	After 2½ years, still a tendency to inversion and adduction of forefoot Operative procedures indicated: stabilization of foot, osteotomy of tibia.
I 256 4 F	4, 5L All sacral +++	Pes equinovarus, right Pes calcaneovalgus, left (Hypesthesia of feet and saddle area)	Wedging plasters to left foot, and manipulations under anesthesia	Patient walking well after 1 year; incontinent of urine and feces Removal of large lipoma overlying spina bifida recommended.
J 97 7 F	All lumbar and sacral vertebræ ++++	Flail lower extremities; contractures of knees. Bilateral pes equinus Dislocation of hip, left	Deformities corrected by wedging plasters	Walking begun with braces and crutches Patient incontinent of urine and feces Prognosis poor
J 171 11 F	5L, all sacral +++	Pes equinovarus, right	Lengthening of heel cord; triple arthrodesis	Tendency to recurrence noted after 1 year Transplant of anterior tibial tendon to mid tarsus to be done later

TABLE II.—CASES SHOWING FOOT DEFORMITIES IN ASSOCIATION WITH SPINA BIFIDA OCCULTA —Continued

Patient Age (years) Sex	Spinal defect	Examination	Treatment	Remarks
K 137 13 F	12D to 2S ++++	Almost flail left lower extremity; contracture of left knee; left hip markedly abducted and externally rotated Pes equinovarus with some cavus, left	Lengthening of heel cord, left; triple arthrodesis, left. Osteotomy of tibia, left. Deformity of hip corrected by traction	Shortening of the extremity remains as this patient's chief difficulty Walks with lift to shoe
I 18 3 F	3, 4, 5L ++++	Dislocation of hip, left Pes equinovarus, right Pes valgus, left	Manipulation of feet under anesthesia Lengthening of heel cord, section of peroneals and dorsiflexors of ankle, left Open reduction of hip, left	Walking unaided after 2 years To have stabilization of feet later
2124 13 F	1L, all sacral ++++	Pes equinovarus, left Paralysis of dorsiflexors of toes, posterior tibial, and peroneals, left, with weakness of gastrocnemius	Stabilization of foot recommended	Operative treatment declined

2. Deformities of the feet of various types were found in both groups of cases. These deformities were particularly resistant to treatment, and usually required some form of operative correction. Arthrodesis of the tarsal joints, and transplantation of the tendons about the ankle were the operations most frequently performed.

3. Congenital dislocations of the hip joint were also found with both the occult and the frank types of spina bifida. These dislocations showed no distinctive clinical features and were treated according to rules applicable to the handling of congenital hip dislocations in general.

4. Seven cases of scoliosis were found with spina bifida occulta as a concomitant condition. These cases were indistinguishable in their clinical features from other idiopathic spinal curvatures, and were given no special treatment.

5. Incontinence of bladder and rectum, present since birth, was an important complicating factor in the group of spina bifida occulta cases as well as among the cases of repaired meningocele or myelomeningocele. The present hopeless outlook for these cases of incontinence would seem to justify any operative procedure holding promise of symptomatic relief of the condition.

6. Causal intervention, as represented by exploratory laminectomy in cases of spina bifida occulta showing signs and symptoms, has not been attempted. In cases absolutely refractory to local operative procedures, or in cases in which the signs and symptoms are definitely progressive and distressing, this type of surgical treatment would seem to be indicated. In the handling of spina bifida in childhood, however, the orthopedic surgeon deals chiefly with deformities and disturbances of function which have been present since birth, and are relatively static. Symptomatic improvement of these disabilities by local operative procedures is, therefore, all that is generally required.

I wish to express here my appreciation for the advice given by Dr. C. H. Crego, Jr., Dr. H. R. McCarroll, and Dr. J. Albert Key, in the analysis of this group of cases.

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EXTRA-UTERINE PREGNANCY

An Analysis of Three Hundred Thirteen Cases from the Harlem Hospital

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THIS study represents an analysis of 313 cases of extra-uterine pregnancy admitted to the Harlem Hospital from March, 1917, to February, 1934. For the past 4 years a special chart has been used to record these cases. By means of these charts, all the symptoms are minutely analyzed. Before the introduction of these charts, the histories were not taken so critically so that whenever symptoms are not specifically described they cannot be included in the analysis.

The incidence of extra-uterine pregnancy at Harlem Hospital for this 17 year period can be seen in Table I.

TABLE I.—INCIDENCE OF ECTOPIC PREGNANCIES

Year	Gynecological total admissions	Ectopic pregnancies	Per cent
1917	*260	19	7.2
1918	*292	20	6.8
1919	*290	18	6.2
1920	*321	16	4.9
1921	*286	15	5.2
1922	*389	17	4.3
1923	*423	24	5.6
1924	*400	16	4.0
1925	*519	12	2.3
1926	*492	14	2.8
1927	968	23	2.3
1928	752	21	2.7
1929	716	17	2.3
1930	704	19	2.6
1931	799	16	2.1
1932	736	29	3.9
1933	557	14	2.5
1934	156 Jan. to March	3	1.8
Totals:	9060	313	3.49

*Abortions, not included, were admitted to Obstetrical Service during those years.

The incidence of extra-uterine pregnancy during the years 1917–1924 was much higher than it has been since. This is particularly true for the years 1917–1919. The incidence of extra-uterine pregnancies for the entire series per total number of gynecological admissions is 3.49 per cent. The incidence during 1917 was 7.2 per cent. Prior to 1917 the annual incidence was about 7 per cent.

AGE GROUPS

In regard to the age, most of the patients were between 20 and 39 years of age, 170 were between 20 and 29, and 123 between 30 and 39 years. In 11 cases the patients were in the second decade and in 9 cases in the fifth decade. The total number of cases was 313; of these, 174 were colored patients, 103 white patients, and in 36 the color was not specified (Table II).

TABLE II.—AGE GROUPS

	10–19 years	20–29 years	30–39 years	40–49 years	Totals
Colored	8	104	58	4	174
White	3	49	47	4	103
Unspecified	0	17	18	1	36
Total	11	170	123	9	313

ANATOMICAL DIVISIONS

In analyzing the cases, they have been studied on the basis of their anatomical location. The subdivisions of the tube are as follows: interstitial portion, or that part which traverses the uterine horn; the isthmial portion, or the constricted mesial third; the ampullary portion, or the outer two-thirds of the tube. The cases of ovarian or tubo-ovarian pregnancies in which the tube is obviously involved, are included under the ampullary portion. Those cases with implantation of the placenta in the free peritoneal cavity are designated abdominal pregnancies. In this analysis, 4 such cases are included, all of which are secondary to ampullary implantations.

In this anatomical division there are 64 cases of ampullary abortion, 87 cases of ampullary rupture, 34 of isthmial rupture, 14 of interstitial rupture, 88 cases in which the site was not specified, 14 cases of unruptured ampullary gestation. There are also 5 cases in which the patients died without operation, 4 in which posterior colpotomy was performed, and 3 in which laparotomy was performed for pelvic abscesses due to infection of old hematoceles.

DEATHS

Out of the series of 313 cases there were 26 deaths (8.3 per cent), the greatest number occurring in the third decade, the period of greatest frequency (Table III).

TABLE III.—DEATHS

		Under 20	20–29	30–39	40 plus
White	6	0	2	3	1
Colored	18	0	12	5	
Unspecified	2	0	1	1	
Total	26	0	15	9	1

The greatest number of deaths, 10 (11.2 per cent), occurred in the group in which the site of the gestation was not noted. There were 6 deaths in 87 ruptured ampullary pregnancies (6.9 per cent), 3 deaths in 14 interstitial pregnancies (21.4 per cent), 1 death following ampullary abortion, 1 death following posterior colpotomy. There were 5 deaths in which the patients were too ill to be operated upon or else died during induction of anesthesia. The mortality rate for the series is 8.3 per cent (Table IV).

Of the 26 deaths, 10 patients died of shock shortly after the operation. Four more died of delayed shock during the course of the next few days. There were 5 patients who were moribund on admission and died without operation. Two patients died of generalized peritonitis. One of these was a secondary abdominal pregnancy and operation was carried out. The other patient was too ill to be operated upon. Posterior colpotomy revealed blood and pus from an infected hematocele. There was 1 death from adynamic ileus, 2 from pulmonary embolism, 1 from pneumonia, and 1 from sepsis. This last patient lived for 1 year and 4 days following operation and developed multiple osteomyelitic foci. Therefore, of the 26 deaths, 19 followed abdominal operations, which gives an operative mortality of 6 per cent. An analysis of the mortality according to the anatomical location is taken up in Table IV.

TABLE IV.—MORTALITY

	Number of cases	Deaths	Percentage
Ampullary abortion	64	1	1.42
Ampullary rupture	87	6*	6.9
Isthmial rupture	34	0	0
Interstitial rupture	14	3	21.4
Rupture, site not specified	88	10*	11.3
Unruptured ampullary	14	0	0
Died unoperated upon	5	5	100
Posterior colpotomy	4	1	25
Laparotomy for pelvic abscess	3	0	0
Total	313	26	8.3

*Includes a case of secondary abdominal pregnancy.

CORRECT PRE-OPERATIVE DIAGNOSIS

The correct pre-operative diagnosis was made in 45 of the 65 ampullary abortions (70.3 per cent); in 75 of 87 ampullary ruptures (86.2 per cent); in 29 of 34 isthmial ruptures (85.2 per cent); in 12 of 14 ruptured interstitial pregnancies (85.7 per cent); in 76 of 88 ruptured extra-uterine pregnancies, site not noted (86.3 per cent). In a series of 14 unruptured ampullary pregnancies, the correct pre-operative diagnosis was made 6 times, or 42.8 per cent. It is thus evident that in tubal rupture, the clinical picture is more apparent than it is in tubal abortions. The correctness of pre-operative diagnosis is approximately 15 per cent higher in the former group. In the unruptured ampullary pregnancies, the correct pre-operative diagnosis was made in 6 of 14 cases, or 42.8 per cent. Three laparotomies were performed for pelvic abscesses and evidence of old ectopic pregnancies were found. None of these were diagnosed correctly before operation. Thus, of 304 laparotomies, 243 were correctly diagnosed, giving a percentage of 79.9 (Table V).

TABLE V.—CORRECT PRE-OPERATIVE DIAGNOSIS

	Correct	Incorrect	Total	Percentage
Ampullary abortion	45	19	64	70.3
Ampullary rupture	75	12	87	86.2
Isthmial rupture	29	5	34	85.2
Interstitial rupture	12	1	14	85.7
Rupture—site not specified	76	22	88	86.3
Unruptured ampullary	6	8	14	42.8
Laparotomy for pelvic abscess	0	3	3	0
Total number of patients operated upon			304	
Total number of correct diagnoses			243	
Percentage of correct diagnoses				79.9

NUMBER OF PREVIOUS PREGNANCIES

The number of previous pregnancies, including abortions, was indicated in only 236 of the 313 cases. There were 48 patients who were pregnant for the first time (Table VI).

TABLE VI.—NUMBER OF PREVIOUS PREGNANCIES INCLUDING ABORTIONS

None	48	5	18
1	60	6	16
2	59	7	5
3	37	8	2
4	29	9 or more	10

The incidence of ectopic pregnancies is nulliparous women is seen to be considerably lower than in the group in which the patients have been pregnant once or twice before.

DAYS BEFORE ONSET

The number of days before onset of symptoms following the last menstrual period is quite constant. Considering the time period in 10 day groups, it is thus seen that the greatest number of cases of ampullary abortion occurred in patients in the period between 40 and 49 days postmenstrual. The ectopic pregnancies which went on to rupture progressed for another 10 days before the onset of symptoms. This holds true for all groups except that in which the site of rupture is not mentioned. Although the date of the last menstrual period can not always be accurately ascertained, it can be seen from Table VII that these

TABLE VII.—NUMBER OF DAYS BEFORE ONSET OF SYMPTOMS

Days post-menstrual	Ampullary abortion	Ampullary rupture	Isthmial rupture	Interstitial rupture	Rupture—site unknown	Unruptured
10–19	4	1	1		10	1
20–29	4	3		1	4	2
30–39	12	11	4	1	31	2
40–49	13	10	6	3	42	2
50–59	6	22	7	4	32	
60–69	11	15	6	1	7	
70–79	3	10	1	1	3	
80–89	1	6	1		3	
90–99		1			3	1
100–109	1		1			
110–119						
120 plus					1	
Mean	40	50	50	50	40	30

cases fall into definite groups which give means which are constant enough to be significant.

There are 47 cases in which the acute picture (pain or bleeding) began before the onset of the next period. There were 14 ampullary abortions which occurred before the anticipated period, 12 ruptured ampullary pregnancies, 3 isthmial and 2 interstitial. Out of 14 unruptured ampullary pregnancies only 2 occurred in this manner. It is most unlikely that the last noted period was normal. Conception undoubtedly occurred before that time. It is important to bear in mind that even if a woman gives no history of menstrual irregularities or amenorrhea, she may not only be pregnant but may be concealing a ruptured ectopic pregnancy. This was so in 15 per cent of the cases in this series (Table VIII).

TABLE VIII.—CASES IN WHICH ACUTE PICTURE (PAIN OR BLEEDING) BEGAN BEFORE THE EXPECTED ONSET OF NEXT REGULAR PERIOD

		Per cent
Unruptured ampullary	2	
Ampullary abortion	14	
Ampullary rupture	12	
Isthmial rupture	3	
Interstitial rupture	2	
Rupture—site not specified	14	
Total	47	15

ANALYSIS OF SYMPTOMS

Onset. In 204 cases (65.2 per cent) a sudden onset of symptoms was noted. The highest incidence was observed in the moribund group (100 per cent) and ruptured interstitial group (85.7 per cent). A sudden onset occurred more frequently in the ruptured isthmial (79.4 per cent) than in the ruptured ampullary (75.8 per cent). The lowest incidence of acute onset occurred in the unruptured ampullary group (35.7 per cent) and in the ampullary abortion group (53.1 per cent) (Table IX).

Character of pain. Here again, the same relationship between implantations at the uterine end of the tube and the character of the pain is noted (Table IX). The highest incidence of cases beginning with sharp pain is noted in the ruptured isthmial group (91.1 per cent). The ruptured interstitial group contained 2 cases that began with a gradual onset so these 2 cases lower the incidence to 85.7 per cent. The lowest incidence is again noted in the unruptured and ampullary abortion group. In 9 cases, a definite history of no pain was obtained. No pain was present in 4 of the 14 unruptured ampullary pregnancies. There was no pain in 1 case of ampullary rupture, in 2 cases of rupture, site not noted, and in 2 cases of ampullary abortions. In the most acute groups, moribund, interstitial and isthmial—there were no cases without the symptom of pain. In the 9 cases in which pain was absent, the hyposensitive factor must be considered. In such cases, one should attempt to elicit substitution symptoms.

TABLE IX.—ANALYSIS OF SYMPTOMS

	No. of cases	Onset				Pain				Attacks			
		Sudden	Per cent	Gradual	Per cent	Sharp	Per cent	Dull	Per cent	Single	Per cent	Rep'ted	Per cent
Ampullary abortion	64	34	53.1	30	46.9	47	73.4	17	26.5	6	9.3	58	90.6
Ampullary rupture	87	66	75.8	21	24.1	74	85.0	11	12.6	38	43.6	48	55.1
Isthmial rupture	34	27	79.4	6	17.6	31	91.1	2	5.8	16	47	16	47
Interstitial rupture	14	12	85.7	2	14.2	12	85.7	2	14.2	8	57.1	3	21.3
Rupture—site unknown	88	51	57.3	37	41.5	67	75.2	18	20.2	22	24.7	62	67.4
Unruptured	14	5	35.7	9	64.2	8	57.1	2	14.2	3	21.3	5	35.7
Died unoperated upon	5	5	100	0		5	100	0		5	100	0	
Posterior colpotomy	4	1	25	3	75	3	75	1	25	0		4	100
Laparotomy or pelvic abscess	3	3	100	0		3	100	0		0		3	100
Total number of cases	313	204		109		250		53		98		209	
Percentages		65.2		34.8		80.0		17.2		31.3		68.7	

TABLE X.—LOCATION AND RADIATION OF PAIN

	Total No. of cases	Location						Radiation				
		Hypo-gastric	Per cent	Epi-gastric	Per cent	Para-umbilical	Per cent	Shoul-ders	Back	Legs	Blad-der	Rec-tum
Ampullary abortion	64	57	87.5	7	10.9	2	3.1	3	8	7	13	10
Ampullary rupture	87	71	81.6	7	8	2	2.2	10	14	2	8	5
Isthmial rupture	34	29	85.2	3	8.8	1	2.9	3	6	1	6	6
Interstitial rupture	14	6	42.8	2	14.2			4	3			2
Rupture—site unknown	88	60	68.5	19	21.3			4	12	4	12	4
Unruptured ampullary	14	4	28.5	1	7.1					1	1	1
Died unoperated upon	5	3	60	2	40						1	1
Posterior colpotomy	4	3	75								3	
Laparotomy for pelvic abscess	3	3	100									
Totals		236		41		5		24	43	15	44	29
Percentages		75.4		13.0		1.4		8.0	14	4.2	14	9

Number of attacks of pain or bleeding. The highest incidence of repeated attacks occurred in the ampullary abortion group, and the lowest in those that were ushered in with an acute onset (Table IX). In all the above, the gravity of the lesion increases the nearer the implantation is to the horn of the uterus. It is fortunate, however, in that the incidence of these conditions decreases as the uterine horn is approached, the smallest number of ectopics being interstitial.

Location and radiation of pain. In 75.4 per cent of the cases, the pain was confined to the lower abdomen, the highest incidence being noted in the ampullary abortion group and the lowest in the interstitial group. In only 24 cases was radiation of pain to the shoulders specifically noted (8 per cent). Pain radiating to the back was noted in 43 cases (14 per cent), to the legs in 15 cases (4.2 per cent). Bladder and rectal disturbances were noted in 44 and 29 cases respectively (14 per cent and 9 per cent) (Table X).

Faintness and syncope. A history of faintness and syncope has always been considered of great diagnostic importance. Actual syncope occurred in 205 cases (64.8 per cent), faintness in 59 cases (18.8 per cent). Combining these groups, these symptoms were noted in 264 cases (83.6 per cent). Syncope occurred in all the moribund unoperated upon patients. In the patients operated upon, it was most frequently encountered in the group of ruptured ampullary pregnancies and least in the group of ampullary abortions. It did not cccur in any of the unruptured ampullary pregnancies. In none of these cases had intraperitoneal hemorrhage occurred. Although syncope was noted in only 5 of the 14 ruptured interstitial pregnancies, it is likely that these figures are incomplete due to the existing emergency. The incidence of

faintness was higher in the isthmial rupture group (26.4 per cent) than in the ampullary rupture group (25.2 per cent) (Table XI).

TABLE XI.—HISTORY OF FAINTNESS AND SYNCOPE

	Totals	Faintness	Per cent	Syncope	Per cent
Ampullary abortion	64	13	20.3	14	21.7
Ampullary rupture	87	22	25.2	40	45.9
Isthmial rupture	34	9	26.4	13	38.2
Interstitial rupture	14	2	14.2	5	35.7
Rupture—site unknown	88	10	11.7	28	31.4
Unruptured ampullary	14	2	14.2		
Died unoperated upon	5			5	100
Posterior colpotomy	4	1	25		
Laparotomy for pelvic abscess	3				
Totals	230	59	18.8	205	64.8

Vaginal bleeding. Vaginal bleeding occurred in 230 cases (73.5 per cent). It was absent in 44 cases (14 per cent). Since these figures represent only 274 of 313 cases, it is significant that at least 14 per cent of all extra-uterine pregnancies are admitted without vaginal bleeding. Of the cases presenting vaginal bleeding, the ampullary abortions and unruptured ampullary pregnancies have the highest incidence (90.6 per cent and 92.3 per cent). The lowest incidence occurred in the ruptured isthmial (61.7 per cent) and ruptured interstitial (50 per cent) groups. This is of great clinical significance. The patients who bleed seek medical aid earlier. The patients who have no bleeding may progress further along in their pregnancies and therefore go on to rupture. The analysis of the number of days before the onset of symptoms substantiates this point. This was taken up in Table VII, in which the number of days postmenstrual was considered in 10 day groups. The greatest number of cases for a given 10 day group is considered the mean. The greatest number of cases of unruptured ampullary pregnancies occurred in the 30 to 40 day group. For the ampullary abortions, in the 40 to 50 day group, and for the ruptured ampullary, isthmial, and interstitial abortions in the 50 to 60 day group. The group of tubal ruptures, site not indicated, falls in the 40 to 50 day period. Bleeding occurred only in 3 out of 5 moribund patients who died without operation (Table XII).

TABLE XII.—VAGINAL BLEEDING

	No. of cases	Present	Per cent	Absent	Per cent
Ampullary abortion	64	58	90.6	6	9.3
Ampullary rupture	87	56	64.3	11	12.6
Isthmial rupture	34	21	61.7	8	23.5
Interstitial rupture	14	7	50	5	35.7
Rupture—site unknown	88	67	75.2	12	13.4
Unruptured ampullary	14	13	92.3	1	7.1
Died unoperated upon	5	3	60	1	20
Posterior colpotomy	4	3	75		
Laparotomy for pelvic abscess	3	2	66.6		
Totals	313	230	73.5	44	14.0

Associated symptoms. Chills were noted in 10 ruptured ectopic gestations, 5 ampullary abortions, and 1 unruptured ampullary pregnancy. Of the 10 ruptured ectopic gestations only 6 were definitely infected, the 4 others presented no clinical evidence to substantiate the presence of an infection. Two of the 5 patients with ampullary abortions had elevated temperatures. One unruptured ampullary pregnancy gave a history of chills and fever. Admission temperature was 100 degrees with a pulse of 90. The subsequent course did not indicate infection (Table XIII).

TABLE XIII.—ASSOCIATED SYMPTOMS

	No. of cases	Chills	Nausea	Per cent	Vomiting	Per-cent	Diarrhea
Ampullary abortion	64	5	8	12.5	24	37.5	
Ampullary rupture	87	3	4	4.5	42	48.2	1
Isthmial rupture	34		3	8.8	16	47	
Interstitial rupture	14				7	50	
Rupture—site unknown	88	7	7	7.8	40	44.9	
Unruptured ampullary	14	1	1	7.1	2	14	
Died unoperated upon	5						
Posterior colpotomy	4				1	25	
Laparotomy for pelvic abscess	3				1	33.3	
Totals	313	16	23		133		1
Percentages		5.2			42.8		0.37

A history of nausea was elicited from 23 patients. Vomiting was noted in 133 other cases, diarrhea once. Therefore of 313 cases, gastrointestinal disturbances were noted in 157 cases (50 per cent) (Table XIII).

CONDITION ON ADMISSION

There were 223 patients admitted who were acutely ill (71.2 per cent) and 83 who were not (26.7 per cent). The ruptured interstitial pregnancies had the highest incidence (92.3 per cent) next to the moribund group (100 per cent). The

TABLE XIV.—CONDITION ON ADMISSION

	No. of cases	Acutely ill	Per cent	Not acutely ill	Per cent	Anemia			
						Sudden	Per cent	Gradual	Per cent
Ampullary abortion	64	33	51.5	31	48.4	15	23.4	45	70.2
Ampullary rupture	87	70	80.4	14	16	53	60.8	28	32
Isthmial rupture	34	30	88	3	8.8	21	61.6	11	32.3
Interstitial rupture	14	13	92.3	1	7.1	13	92.3	1	7.1
Rupture—site unknown	88	65	73	20	23.4	14	46	38	42.6
Unruptured ampullary	14	2	14.2	12	85.6				
Died unoperated upon	5	5	100			5	100		
Posterior colpotomy	4	2	50	2	50			3	75
Laparotomy for pelvic abscess	3	3	100					3	100
Totals		223		83		121		129	
Percentages		71.2		26.9		49.8		41.2	

TABLE XV.—HEMOGLOBIN ON ADMISSION

	No. of cases	20 per cent plus	30 per cent plus	40 per cent plus	50 per cent plus	60 per cent plus	70 per cent plus	80 per cent plus	90 per cent plus	Mean percentage
Ampullary abortion	64		1	1	7	6	22	12	3	70–79
Ampullary rupture	87	1	6	6	14	23	21	3	1	60–69
Isthmial rupture	34		1	8	3	7	8	4		40–49 70–79
Interstitial rupture	14		2	2	1	4	3	1		60–69
Rupture—site unknown	88	4	0	8	12	17	11	11	4	60–69
Unruptured	14					2	3	2	1	70–79
Died unoperated upon.	5			1	3					50–59
Post colpotomy	4				1		2	1		
Laparotomy for pelvic abscess	3				1	1	1			

TABLE XVI.—ABDOMINAL TENDERNESS

	No. of cases	Generalized	Per cent	Localized	Per cent	Absent	Per cent	Pelvic Mass			
								Yes	Per cent	No.	Per cent
Ampullary abortion	64	8	12.5	48	45.0	10	15.6	57	87.5	7	10.9
Ampullary rupture	87	17	19.5	57	65.5	6	6.7	65	74.7	19	26.8
Isthmial rupture	34	9	26.1	21	61.7	1	2.9	21	61.7	8	23.2
Interstitial rupture	14	6	42.8	8	57.1			7	50	6	42.8
Rupture—site unknown	88	14	15.7	69	77.5	4	44.9	70	78.6	13	14.6
Unruptured ampullary	14			11	78.4	2	14.2	13	92.8	1	7.1
Died unoperated upon	5	2	40	3	60			3	60	1	20
Posterior colpotomy	4	2	50	2	50			4	100		
Laparotomy for pelvic abscess	3	1	33.3	2	66.6			3	100		
Totals		59		221		23		243		55	
Percentages		18.8		71.2		7.5		77.9		17.5	

ruptured isthmial group had a higher incidence (88 per cent) than the ruptured ampullary group (80.4 per cent). The unruptured ampullary pregnancies showed the lowest incidence of acutely ill patients (14.2 per cent) and the ampullary abortions next (51.5 per cent). Only 158 of the 223

TABLE XVII.—BLOOD IN PERITONEAL CAVITY

	Totals	Fresh	Per cent	Old	Per cent	None	Per cent
Ampullary abortion	64	50	78.1	13	20.3		
Ampullary rupture	87	79	90.8	6	6.8		
Isthmial rupture	34	30	88.2	2	5.8		
Interstitial rupture	14	14	100				
Rupture—site unknown	88	66	74.1	14	15.7		
Unruptured ampullary	14					14	100
Died unoperated upon	5						
Posterior colpotomy	4			4	100		
Laparotomy for pelvic abscess	3						
Totals		239		38		14	
Percentages		75.8		12.1		4.5	

acutely ill patients (51.1 per cent) presented the picture of sudden massive hemorrhage. Gradual anemia was noted in 129 cases (41.2 per cent). Again the sudden anemia is most frequently found in the group of moribund and ruptured interstitial pregnancies and least in the group of ampullary abortions (Table XIV).

Hemoglobin. The hemoglobin determinations are analyzed in Table XV. These figures are interesting but no attempt will be made to interpret them as the hemoglobin determination during or immediately following hemorrhage is not the true reading. The hemoglobin was found to be highest in the group of unruptured ampullary pregnancies (no peritoneal hemorrhage) and in the ampullary abortions (slow bleeding).

The average hemoglobin for the entire series is found to fall in the 60 per cent to 70 per cent group. On a service in which the average hemoglobin for all admissions is around 80 per cent or more, it is very significant to find a hemoglobin of 60 per cent. Even in the absence of accompanying symptoms, it is imperative that the etiology of such a degree of anemia should be ascertained.

Abdominal tenderness. Abdominal tenderness was found to be localized in 221 cases (71.2 per cent), generalized in 59 (18.8 per cent) and absent in 23 (7.5 per cent). Generalized tenderness was most frequently found in the ruptured interstitial group, next in the moribund group and isthmial rupture group, and least in the ampullary abortion group. The highest incidence for localized tenderness was in the unruptured ampullary group. It is thus seen that the less acute the clinical condition, the more likely that the tenderness will be localized and vice versa (Table XVI).

Presence of pelvic masses. The presence of palpable pelvic mass was noted in 243 cases (77.9 per cent). No palpable masses were noted in 55 cases (17.5 per cent). The presence of a pelvic mass is lowest in the groups which present the most acute pictures and highest in the groups which have the lowest incidence of acute symptoms. Walling off and hematocele formation occur most often when the hemorrhage is small in amount and repeated, and are least likely to occur in the presence of sudden massive hemorrhage. These processes will therefore accompany repeated attacks. The incidence of repeated attacks is highest in the ampullary abortion group. This observation that pelvic masses most commonly accompany the ampullary implantations is in keeping with the previous observation that the further the implantation is from the uterine horn the less acute the onset and clinical picture (Table XVI).

Blood in peritoneal cavity. Fresh blood was found in 239 cases (75.8 per cent), old blood in 38 (12.1 per cent). No blood was found in the cases of unruptured ampullary pregnancy (Table XVII).

INTERESTING CASES

Previous extra-uterine pregnancies. There were 8 cases in which the patient had a previous ectopic pregnancy. 1, 1 year before, 2, 2 years before, and the others 3, 4, 9 and 15 years previously. There is 1 case in which the patient had an ectopic pregnancy in the stump left following an operation for a similar condition 4 years ago. The incidence is 2.56 per cent.

Abdominal pregnancies. There were 4 secondary abdominal implantations, no primary cases. Two were advanced to almost the fifth month. Strangely enough, both of these were twin pregnancies. One case went to full term with a living baby. The duration of the fourth was not noted. The incidence of secondary abdominal pregnancy for this series is 1.28 per cent.

Bilateral extra-uterine pregnancies. There are 6 cases in which the diagnosis of bilateral extra-uterine pregnancy was made at the operating table. Gross examination revealed bilateral hematosalpinx. In none of these cases, however, is there conclusive microscopic evidence to confirm the diagnosis. It seems more likely that the condition noted was a tubal gestation in one tube with a hematosalpinx in the other.

Other conditions. The presence of an acute salpingitis in the same tube as the ectopic gestation was found in 2 recent cases. It is possible that more have been overlooked. In another case a tubal abortion was found in one tube and the other was the site of a ruptured pyosalpinx. A ruptured ovarian cyst was found accompanying a tubal abortion on the opposite side. A dermoid cyst was found in another case. In 3 cases, supravaginal hysterectomy was performed because of multiple myomata of the uterus.

SUMMARY

1. An analysis of 313 cases of extra-uterine pregnancy is presented, the analysis being based upon the anatomical location of the implantation.

2. The incidence of extra-uterine pregnancies (to the total number of gynecological admissions) is 3.49 per cent.

3. The site of the implantation is found most frequently in the ampullary portion, less in the isthmial, and least frequently in the interstitial portion.

4. The mortality rate for the series is 8.3 per cent. Of the 26 deaths, 19 followed abdominal operation, thus giving an operative death rate of 6 per cent.

5. The correct pre-operative diagnosis was made in 79.9 per cent of the cases.

6. The number of days postmenstrual before the onset of symptoms is found to be greater for the patients who went on to rupture than for those in whom tubal abortion occurred.

7. Fifteen per cent of the patients studied presented no history of amenorrhea at the time of admission.

8. The severity of the clinical picture at the time of admission is directly related to the site of implantation, the nearer to the uterine horn the more sudden the onset and the more serious the effects.

9. Abdominal pain was absent in 9 cases.

10. Faintness, syncope, or both were noted in 83.6 per cent of the cases.

11. Vaginal bleeding was absent in 14 per cent of the cases in the isthmial and interstitial groups.

12. Gastro-intestinal disturbances were noted in 50 per cent of the cases.

Addendum. From March 1, 1934, to June 15, 1934, there have been 7 more extra-uterine pregnancies; 2 ampullary abortions, 3 ampullary ruptures, 1 isthmial rupture, and 1 abdominal pregnancy. The abdominal pregnancy was diagnosed before operation. A five month fetus was removed. No attempt was made to explore, therefore it is not known whether or not this is a primary or secondary abdominal pregnancy. The placenta was left *in situ*. This patient recovered although she still has a discharging wound. This case brings the number of abdominal pregnancies in this series to 5. The grand total of extra-uterine pregnancies is increased to 320.

AN IMPROVED ANESTHETIC TECHNIQUE FOR GENERAL SURGERY[1]

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WITH a view of attempting to improve on the present surgical technique, first, by abolishing psychic influences before operation; second, by securing a better brain block and greater relaxation during operation; and third, by diminishing gas and wound pain after operation, the following agents were used and the procedure as evolved was carried out more or less completely in over 300 patients. In many cases, dilaudid was given solely for the relief of pain and as a sedative both in private and clinic cases by one of us (Fraser).

Reports by Alvarez of the Mayo Clinic and others prompted us to use dilaudid (dihydromorphinone hydrochloride) instead of morphine. Alvarez states: "There is no question that in some cases dilaudid is an ideal analgesic . . . Occasionally the appetite of patients is improved and the appetite of others is not spoiled as much as by morphine . . . Every one who has used dilaudid seems to agree that it has practically no constipating effect . . . It may be particularly useful in those many cases in which the patient with inoperable carcinoma must suffer tortures for several months."

However, Alvarez did not find the *effect* of dilaudid more *lasting* than that of morphine. David states: "Dilaudid acts more rapidly but over a *shorter* period of time than does morphine."

As a long relief from pain is desirable, we determined to use magnesium sulphate with the dilaudid. Harmon states: "When the patient is given morphine in divided doses in magnesium sulphate solution prior to operation, there is a greater postoperative comfort, less nausea and vomiting, and a decreased amount of morphine is used." Smythe states that with "three hypodermic injections of 1/8 grain (8 milligrams) of morphine dissolved in 2 cubic centimeters of a 25 per cent solution of magnesium sulphate with 1/150 grain (0.4 milligram) of atropine added to the second dose at 20 minute intervals, one-third of the patients thus prepared did not require an analgesic after operation. The patients go, on an average, four times as long after an operation before an analgesic is required than patients who were given morphine dissolved in sterile water alone." (Average time with magnesium sulphate 15 hours and without 4 hours.)

While a 50 per cent solution of magnesium sulphate has been used in many thousands of cases (3) successfully, and Smythe has proved beyond doubt that a 25 per cent solution is satisfactory, we determined on a 25 per cent solution for dilaudid. The synergism of magnesium sulphate is even more striking than with morphine (4). Both magnesium sulphate and dilaudid are analgesics—our usual dose is 1/48 grain and in some cases 1/96 grain. Alvarez states: "For one of my patients, the drug worked best when combined with a small dose of barbital. This tended to eliminate the nausea otherwise produced in her by a large dose." One of us (Gwathmey) had noted that nausea was diminished or entirely eliminated when a barbiturate was used preliminary to any inhalation anesthetic. We therefore gave all our patients a barbiturate—ipral sodium (ethylisopropylbarbituric acid), usually 2 tablets (8 grains).

Ether is unquestionably the safest and most relaxant of all anesthetics. The nausea and vomiting that is usual after inhalation ether is practically eliminated when mixed with oil and given per rectum. Two and one-half ounces of ether in oil per rectum, even when preceded by ipral and dilaudid magnesium, will never relax a patient to such an extent that an anesthetist is necessary before the patient is brought to the operating room (45 minutes). The supplement during operation is nitrous oxide and oxygen with an open mask and, as the operation is completed, oxygen and carbon dioxide. The final technique is: 2 hours before operation, 2 tablets per os of ipral sodium (8 grains). One hour before operation, first hypodermic intramuscularly of dilaudid, grains 1/48 in 25 per cent solution of magnesium sulphate; repeat in 15 minutes. Now turn patient on left side, Sims position and give the following retention enema:

Ether	2½ ounces
Olive oil	1½ ounces
Clorbutanol	10 grains

For athletes, day laborers, and alcoholics, repeat the hypodermic, if necessary. The result of this medication is a quiet sleep when patient is brought to the operating room. Until this time no expert attention is necessary and was never given in any of our cases. This quiet sleep is converted into surgical anesthesia, and relaxation with an open mask (not the usual mask and bag), nitrous oxide (or ethylene) and oxygen being used—15 per cent

[1]Surgical staff meeting of the Metropolitan Hospital, January 10, 1935.

to 50 per cent to which a 5 per cent vapor of ether may be added, if necessary. The physiological balance between respiration and circulation is retained, with respiratory and circulatory rate normal. This is not true of any form of inhalation anesthesia, unless heavily premedicated. This sequence of hypnotics and analgesics followed by a mild inhalation anesthetic approaches the ideal. The respiration, circulation and blood pressure would be only slightly altered by the necessary handling of a new-growth or important vessels and nerves but quickly returns to normal as operation approaches completion. The patient is pink at all times. The relaxation is second only to that obtained by spinal and, in some of our cases, was equally as good (Fraser). In one case the supplement was entirely oxygen and carbon dioxide, 6 per cent; at the end of the operation respiration was normal.

With this method, all possible emergencies are provided for. If loss of blood or unusual delay, a hypodermoclysis of normal saline, 500 to 1500 cubic centimeters, plus oxygen and carbon dioxide meets all requirements. The patient is unquestionably safer and more comfortable afterward than with any other method we now have. The long, quiet sleep after the operation is restful and life-saving, enabling the tissues to resume their normal relationship without painful reaction. With this method and technique, the convalescence of the patient starts on the operating table and this is as it should be.

ANALYSIS OF 40 CASES AT METROPOLITAN HOSPITAL

All statements of Alvarez in regard to dilaudid have been verified and concurred in by us (and also by Stroud). An analysis of 40 cases at the Metropolitan Hospital shows the following: All operations were major multiple in type. The average sleep after operation was 7 hours, with patient on right or left side requiring no expert supervision; lid reflex was active; breathing, natural. In the surface cases, no supplement was needed. In intra-abdominal cases a supplement was always used. The patients awoke in a pain free state and convalescence was quiet and uneventful. The addition of a 25 per cent solution of magnesium sulphate (C.P.) definitely decreased the dosage of the dilaudid and prolonged its effect in [illegible] cases, as compared to those of others. In a vast majority of cases the patients awoke without pain, nausea or vomiting. Ether vomiting is a thing of the past.

CONCLUSION

1. A definite prolongation of the effect of dilaudid is made by the addition of a 25 per cent solution of magnesium sulphate.

2. The small amount of ether counteracts the depressing effect of dilaudid magnesium solution on the respiratory center.

3. A comfortable relaxation with less shock and greater postoperative comfort occurs with this technique than with any procedure heretofore used.

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EXPERIENCES WITH THE LATZKO CESAREAN SECTION[1]

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DEEPLY impressed with the enormous frequency with which craniotomy was done on the living child, Frank, among others, sought another approach to the fetus *in utero* when the abdominal method was indicated by a disproportion but contra-indicated by the presence of a potential or frank intrapartum infection. In 1907, he devised the suprasymphyseal transperitoneal cesarean section, extraperitonealizing the incision in the lower segment by sewing a mobilized flap of visceral peritoneum to the parietal peritoneum. With this method he hoped to avoid the usual complicating peritonitis and mortality which attended the classical section. To demonstrate the efficacy of his method, he applied it in 13 frankly "unclean cases." As a result he obtained 13 live babies and mothers, a striking contrast to the results previously obtained by the use of craniotomy on the living child, which frequently was productive of permanent injury to the mother, and the evident 100 per cent fetal mortality.

Sellheim carried this one step further and devised the purely extraperitoneal approach to the lower segment of the uterus through the space enclosed by the vesico-uterine reflection of peritoneum. He soon abandoned this method because of the marked frequency with which the bladder was injured and the peritoneal cavity opened. He then revived the Frank technique with some modifications.

In 1908, Latzko demonstrated a comparatively simple approach to the lower uterine segment in a purely extraperitoneal manner. This method was most practical when the patient had been in labor for some hours, at which time the lower uterine segment had been thinned out and the bladder made more mobile so that one gained easy access to the lower segment.

In this country the operation was introduced by Jellinghaus at the Lying-In and the Nursery and Childs Hospitals in 1923. The experiences with the operation in these two institutions were reported by Steele and Burns.

In 1929, Dr. Meyer Rosensohn introduced the operation to the Bronx Hospital. The present report is based on a series of 19 cases on whom the operation was performed. The technique used was as follows: After the usual preparation of the abdomen and vulva, the bladder was emptied, and then filled with 150–200 cubic centimeters of boric acid solution by means of an indwelling catheter. This procedure raises the bladder out of the pelvis and facilitates its mobilization. In addition, what is more important, it elevates the vesico-uterine fold of peritoneum, thus freeing it from the lower uterine segment.

A vertical incision is then made along the left paramedian line dividing the skin, fascia, and fibers of the left rectus muscle. The posterior layer of the sheath of the rectus muscle is now incised, great care being used to avoid the distended bladder which lies directly underneath. By means of blunt finger dissection, the left anterior surface of the bladder is then freed from the posterior surface of the posterior sheath of the rectus muscle. The fatty tissue surrounding the left lateral border of the bladder is now perforated with the blunt finger and dissected away until the anterior surface of the lower uterine segment is exposed. At this point it is well to give attention to a white band of tissue which extends from the upper end of the left lateral border of the bladder to the lateral pelvic wall. It can be readily observed pulling in the opposite direction when traction is made on the full bladder by means of a blunt retractor. This may be very carefully nicked, thus exposing the peritoneal fold which is left intact, and pushed up out of the way by gentle blunt dissection. Extreme care with this disposal of what Latzko called, the ligamentum vesicale laterale, and the peritoneal fold, will invariably prevent opening of the peritoneal cavity. Most often one obtains sufficient exposure in a downward direction, so that both these structures may be left intact. If the peritoneal cavity is opened, prompt suture with continuous plain catgut, before incising the uterus, will serve admirably to prevent any spill. Once more attention is turned to the bladder, which is now completely separated from the lower uterine segment by blunt finger dissection. At this point, especially, the operator should be warned of the danger of perforating the bladder as his finger approaches a very intimate attachment of the base of the bladder to the lower end of the lower uterine segment. Such an accident will occur even when the gentlest form of finger dissection is used, when the bladder is overdistended with too much fluid after it had already become devitalized by hours of incessant pounding from the hard unengaged head wedged in the brim of

[1]From the Obstetric Service of Dr. Meyer Rosensohn, Bronx Hospital.

the pelvis on the one hand, and the firm rigid bony inlet on the other. One can avoid this complication by not overfilling the bladder, and in addition by incising the subvesical fascia which immediately overlies the lower uterine segment, by means of which a simple line of cleavage is obtained. (Halban and Tandler do not consider this a real fascia, but rather a loose areolar tissue interspersed with smooth muscle fibers.) The bladder is now emptied, by releasing the clamp from the indwelling catheter, and retracted to the right by a blunt retractor, the lower uterine segment being thus exposed. If, up to this point, the procedure had been carried out correctly, neither the ureter nor uterine artery will have been exposed, and any danger to them will have been avoided. The incision in the lower segment is now made as close to the median line as is possible without injuring the bladder. We prefer starting this incision by making a small opening in the upper portion of the exposed lower segment with a scalpel, and completing it with a bandage scissors as far down as is compatible with the neighboring anatomy. There is now sufficient room to complete delivery of the child with forceps. Pituitrin may be given directly into the uterine wall, or hypodermically, as one desires, supplemented with an intramuscular ergot preparation, to aid and abet contraction of the uterus, thus preventing unforeseen hemorrhage.

The lower angle of the wound in the uterine wall is now taken up with a No. 2 chromic catgut suture. This is done at this time because it gives one a landmark for the completion of the suture before the field of operation becomes inundated from the flow of blood following the manual removal of the placenta, which is now accomplished. Up to the removal of the placenta, the operation has been a practically bloodless one, unless the operator has strayed from the midline (Case 19), and gone far out into the space between the leaves of the broad ligament where large sinuses have been opened. A temporary hot gauze packing will control such bleeding, usually without any untoward difficulty. The first row of the already anchored suture is now completed in a continuous fashion, and is followed by a continous chromic catgut No. 2 Lembert suture of the overlying subvesical fascia and superficial layer of uterine muscle. The bladder is now refilled in order to observe whether it had been injured in any way during the operation. Such an injury can be detected from the evident escape of fluid at the site of the trauma. A double or triple layer of fine chromic catgut suture, avoiding the mucosal layer of the bladder, is sufficient to re-establish the anatomical continuity of the bladder wall. (This should be followed by the use of a permanent catheter, the drainage being continuous for the first 4 days, then interposing periods of non-drainage in ever increasing duration until the tenth to the fourteenth day when the catheter can be removed.) The lateral border of the bladder is now allowed to return to its normal position after it had been again emptied. A cigarette drain is interposed between the uterine wound and the bladder. The mobilized bladder may or may not be anchored to the posterior sheath of the rectus muscle by one or two interrupted plain catgut sutures. Experience has taught us that the anchorage of the bladder is not entirely essential.

CASE REPORTS

CASE 1. A primipara at term, showed no appreciable dilatation of the cervix after 6 hours of active labor. Three vaginal examinations had been made in the patient's home. The indications for operation were a flat pelvis, unengaged head after 48 hours of ruptured membranes, fetal distress—rate varying from 130–180, irregular. Mother's temperature at time of operation was 100.4 degrees. The peritoneum was opened and promptly sutured. The puerperium was complicated by exudate in the left broad ligament, foul purulent lochia, and edema of the vulva due to lymphatic obstruction. Fever ranged as high as 102.8 degrees with temperature returning to normal on the twenty-first day. Patient was discharged cured on the twenty-fifth day, with a living baby weighing 6 pounds 12 ounces.

CASE 2. A primipara at term. Membranes had been ruptured for 8 hours, she had been 46 hours in active labor, with head unengaged and cervix fully dilated. Three vaginal examinations had been done in the hospital. The fetal heart could not be heard for the last hour of labor. An attempt at craniotomy was a failure due to tetanic spasm of the uterus. Indications for operation were flat pelvis, unsuccessful craniotomy, impending rupture of the uterus. Mother's temperature at time of operation was 102.6 degrees. Catheterization before operation, was productive of bloody urine, although there was no difficulty in filling the bladder. The bladder, tested at operation, revealed no evident injury. The puerperium was complicated by purulent discharge from the abdominal incision, and a vesicovaginal fistula which appeared on the sixth day. Temperature returned to normal on the ninth day, and patient was discharged on the twenty-second day. The craniotomized baby weighed 6 pounds plus. Patient refused operation for fistula at a later date.

CASE 3. A primipara, at term, with cervix two fingers dilated. Two vaginal examinations had been done in the hospital. Labor was complicated by pre-eclampsia. Indications for operation were flat pelvis, unengaged head after 36 hours of ruptured membranes with 30 hours of active labor, temperature 101.8 degrees. The puerperium was complicated by purulent discharge from the abdominal wound and foul lochia. Temperature returned to normal on the thirteenth day, and patient was discharged cured on the sixteenth day. Living baby weighing 8 pounds 9 ounces was delivered.

CASE 4. A primipara, at term, with cervix four fingers dilated. Previous history showed chronic pyelitis. Indica-

tions for operation were flat pelvis, unengaged head after 39 hours of ruptured membranes and 30 hours of active labor. Two vaginal examinations were done in the hospital. Temperature at time of operation was 102.4 degrees. The puerperium was complicated by pyelitis. The temperature returned to normal on the sixteenth day, and patient was discharged cured on the eighteenth day. The wound healed by primary intention. A living baby weighing 7 pounds was delivered.

CASE 5. A primipara, at term, with cervix three fingers dilated. Before onset of labor, patient was convalescing from an attack of influenza. Indications for operation were ample pelvis, unengaged frank breech, after 18 hours of ruptured membranes and 24 hours of active labor, disproportion between a large baby and a normal pelvis. Temperature at time of operation was 100.8. The puerperium was complicated by repeated pulmonary emboli, each attack (three) manifesting itself by sudden onset of pain in chest, shock, and bloody sputum. Temperature returned to normal on the fourteenth day, and patient was discharged improved on the sixteenth day, at her request, to finish convalescence from chest condition at home. Abdominal wound healed by primary intention. Living baby weighing 8 pounds 12 ounces was delivered.

CASE 6. A secundipara, at term, with membranes intact, cervix two fingers dilated. Previous pregnancy terminated in spontaneous delivery of a 7 pound 7 ounce baby. Indications for operation were flat pelvis; unengaged head after 26 hours' labor; fetal distress as evidenced by irregularity of fetal heart sounds, varying from 120–200 in rate; large baby. Temperature of mother at time of operation 102.6 degrees. Puerperium was uneventful, healing taking place by primary union. Temperature returned to normal on the fourth day, and patient was discharged cured on the thirteenth day postpartum. A living baby, weighing 8 pounds 2 ounces was delivered.

CASE 7. A primipara, at term, with cervix four fingers dilated, brow presentation. Indications for operation were ample pelvis with cephalopelvic disproportion, malpresentation unengaged after 20 hours of ruptured membranes and 30 hours of active labor. Temperature at time of operation was 101.6 degrees. Pre-operative catheterization was productive of a bloody urine. Bladder tested at operation was found to be intact. Evidence of uterovesical fistula appeared on the sixth day after operation. Temperature returned to normal on the eighth day, and patient was discharged on the tenth day after signs of fistula had disappeared, to reappear again on the third day of her home stay. A permanent indwelling catheter for the next 10 days served to bring about a complete cure of her bladder injury. A living baby weighing 9 pounds 11 ounces was delivered.

CASE 8. A primipara, at term, with cervix two fingers dilated. Indications for operation were a 36 year old primipara, 9 year sterility, baby important, funnel pelvis, unengaged head after 23 hours of ruptured membranes and 22 hours of active labor. Three vaginal examinations were done in hospital. Temperature at time of operation was 102.2 degrees. Puerperium was uneventful, the wound healing by primary union. Temperature returned to normal on the ninth day, and patient was discharged cured on the eleventh day. A living child weighing 7 pounds 4 ounces was delivered.

CASE 9. A quadripara, at term, with membranes ruptured for 8 hours, in active labor for 30 hours, head unengaged. The family physician had attempted a high forceps operation in the patient's home with cervix incompletely dilated. The forceps slipped, the cervix was lacerated, and patient went into shock. She was removed to the hospital, treated for shock, and then removed to the operating room. Indications for operation were ample pelvis, cephalopelvic disproportion, previous attempt at high forceps, lacerated cervix impending rupture of the uterus. Temperature at time of operation was 100.8 degrees. Puerperium was uneventful, healing was by primary union. A stillbirth infant weighing 10 pounds 5 ounces was delivered. Temperature returned to normal on the eighth day, and patient was discharged cured on the eleventh day.

CASE 10. A primipara, at term, with cervix three fingers dilated, head unengaged, impacted mentoposterior presentation. Three vaginal examinations were done in the hospital. Temperature at time of operation was 100.0 degrees. Indications for operation were ample pelvis with cephalopelvic disproportion, malpresentation after 26 hours' labor and ruptured membranes for 10 hours. The peritoneal cavity was opened, and promptly sutured. Puerperium was uneventful, and healing was by primary union. Temperature returned to normal on the fourteenth day, and patient was discharged cured on the sixteenth day. A living baby weighing 8 pounds 12 ounces was delivered.

CASE 11. A primipara, at term, with cervix three fingers dilated. Two vaginal examinations were done in the patient's home. Indications for operation were funnel pelvis, head unengaged after 36 hours of labor, membranes ruptured for 11 hours, pre-eclampsia. Patient's temperature at time of operation was 100.4 degrees. Bladder was lacerated at operation, and promptly sutured. Temperature returned to normal on the twelfth day, and patient was discharged cured on the fifteenth day. With the aid of a permanent indwelling catheter bladder was healed by the tenth day. A living baby weighing 8 pounds 9 ounces was delivered.

CASE 12. A primipara, at term, 37 years of age. Indications for operation were: a funnel pelvis, non-engagement after 52 hours of ruptured membranes, and 4 hours of active labor. Temperature at time of operation was 100.4 degrees. Three rectal examinations had been made but none per vaginam. Puerperium was uneventful. Temperature returned to normal on the tenth day, healing was by primary intention, and patient was discharged cured on the fourteenth day. A living baby weighing 7 pounds 4 ounces was delivered.

CASE 13. A primipara, at term. Indications for operation were a funnel pelvis, an unengaged frank breech after 36 hours of ruptured membranes and 36 hours of active labor. Six vaginal examinations were done in the hospital. Temperature at time of operation was 101.0 degrees. Puerperium was complicated by suppuration of the abdominal wound. Temperature returned to normal on the tenth day postpartum, and patient was discharged cured on the fourteenth day. A living baby weighing 7 pounds 8 ounces was delivered.

CASE 14. A primipara, at term, with cervix four fingers dilated. Indications for operation were a funnel pelvis, non-engagement after 72 hours of active labor, and membranes ruptured for 72 hours. Patient had four vaginal examinations. Temperature at time of operation was 103.0 degrees. Puerperium was complicated by a pulmonary embolus and infarct of the spleen. Temperature returned to normal on the thirty-sixth day and patient was discharged cured on the forty-second day. A living baby weighing 8 pounds was delivered.

CASE 15. A primipara, at term, with cervix four fingers dilated. Indications for operation were a funnel pelvis, non-engagement after 48 hours of active labor, and ruptured membranes for 48 hours. Temperature at time of operation was 102 degrees. Four vaginal examinations were made. The peritoneum and bladder were opened at time of operation. The bladder was completely healed

TABLE I.—SUMMARY OF THE CASES*

Case Para	Indications for operation						Weight lbs.	Condition	Day temp. normal	P.O. day discharge
	Pelvis	Hours in labor	Hours with ruptured membranes	Dilatation of cervix (fingers)	Temperature of mother	Complications of labor				
1 I	Flat	6	48	0	100.4	Fetal distress	6–12	Living	21	25
2 I	Flat	46	8	Fully	102.6	Unsuccessful craniotomy. Impending rupture of uterus	6	Craniotomy	9	22
3 I	Flat	30	36	II	101.8	Pre-eclampsia	8–9	Living	13	16
4 I	Flat	30	39	IV	102.4		7	Living	16	18
5 I	Normal	24	18	III	100.8	Frank breech. Fetopelvic disproportion. Influenza	8–12	Living	14	16
6 II	Flat	26	0	II	102.6	Fetal distress	8–2	Living	4	13
7 I	Normal	30	20	IV	101.6	Brow presentation. Cephalopelvic disproportion	9–11	Living	8	10
8 I	Funnel	22	23	II	102.2	36 yr. old primipara. 9 yrs. sterility. Baby important	7–4	Living	9	11
9 IV	Normal	30	8	Not record.	100.8	High forceps attempt at home. Cervical laceration. Shock. Cephalopelvic disproportion	10–5	Stillborn	8	11
10 I	Normal	26	10	III	100	Impacted mentoposterior. Cephalopelvic disproportion	8–12	Living	14	16
11 I	Funnel	36	11	III	100.4	Pre-eclampsia	8–9	Living	12	15
12 I	Funnel	4	52	Not record.	100.4		7–4	Living	10	14
13 I	Funnel	36	36	Not record.	101		7–8	Living	10	14
14 I	Funnel	72	72	IV	103		8	Living	36	42
15 I	Funnel	48	48	IV	102		9	Living	10	14
16 I	Flat	24	24	IV	Not record.	Attempt at high forceps on undilated cervix—in hospital. Laceration of cervix. Shock	8	Living	12	14
17 I	Flat	60	60	Fully	102		7–8	Living	10	12
18 I	Flat	24	18	Fully	100	Frank breech	8–3	Living	13	14
19 I	Flat (gen. contr.)	44	44	III		Manual dilatation	7	Living	6	14

*All cases were at term.
All presenting parts unengaged at time of operation.

by tenth day at which time temperature returned to normal. Patient was discharged cured on the fourteenth day. A living baby weighing 9 pounds was born.

CASE 16. A primipara, at term, with cervix four fingers dilated. Numerous vaginal examinations had been made. Indications for operation were a flat pelvis, non-engagement after 24 hours of active labor, and 24 hours of ruptured membranes. The family physician attempted a high forceps operation on an incompletely dilated cervix. The cervix was lacerated, patient in shock. Patient had fallen bodily from delivery table to floor when she was left unattended and was coming out of the anesthesia and shock prior to operation. Puerperium was uneventful, temperature returned to normal on the twelfth day postpartum, and patient was discharged on the fourteenth day. Healing took place by primary union. A living baby weighing 8 pounds was born.

CASE 17. A primipara, at term, with cervix completely dilated. Indications for operation were non-engagement after 60 hours of active labor, membranes ruptured for 60 hours, flat pelvis. Numerous vaginal examinations had been made. Temperature at time of operation was 102.0 degrees. Puerperium was uneventful; healing took place by primary union. Temperature returned to normal on

TABLE II.—OPERATIVE COMPLICATIONS

Case	Nature of complication	Treatment	Result
1	Peritoneum opened	Immediate suture	
10	Peritoneum opened	Immediate suture	
11	Laceration of bladder	Repair with indwelling catheter	Healed in 2 weeks
15	Peritoneum and bladder opened	Immediate suture	Healed on discharge
19	Peritoneum opened. Bleeding from broad ligament	Suture of peritoneum	

TABLE III.—POSTOPERATIVE COMPLICATIONS

Case	Nature of complication	Contributing cause	Treatment	Result
1	Edema of vulva. Foul lochia	Left broad ligament exudate	Incision	Healed
2	Vesicovaginal fistula	Unsuccessful craniotomy	Refused operation	Still present
3	Purulent discharge from wound. Foul lochia			Healed by secondary union
4	Pyelitis	History of chronic pyelitis	Fluids and alkali mixtures	Cured on discharge
5	Repeated pulmonary emboli	Influenza	Medical	Cured on discharge
7	Utero-vesical fistula		Indwelling catheter	Healed in 2 weeks
13	Suppuration of abdominal wound			Healed by secondary union
14	Pulmonary embolus. Infarct of spleen		Medical	Cured
18	Utero-abdominal fistula	Slough of uterine wound		Healed
19	Chill with temperature of 102 first day after operation			Cured

the tenth day, and patient was discharged cured on the twelfth day. A living baby weighing 7 pounds 8 ounces was delivered.

CASE 18. A primipara, at term, with cervix completely dilated. Indications for operation were flat pelvis, non-engagement of a frank breech, in labor for 24 hours, membranes ruptured for 18 hours. Temperature at time of operation was 100.0 degrees. Two vaginal examinations were done in the hospital. The puerperium was complicated by a utero-abdominal fistula, which closed on the tenth day. Temperature returned to normal on the thirteenth day, and patient was discharged on the fourteenth day. A living baby weighing 8 pounds 3 ounces was born.

CASE 19. A primipara, at term, with cervix three fingers dilated. After the patient had been in labor for 40 hours, the family physician decided that dystocia was due to a rigid cervix. He thereupon proceeded to do a manual dilatation, but was unsuccessful in his attempt. Indications for operation were generally contracted flat pelvis, non-engagement after 44 hours of labor, and a like duration of ruptured membranes, previous attempt at *accouchement a forcé*. The peritoneum was torn because the operator strayed too far afield, thus getting into the thin posterior layer of the broad ligament. In attempting to sew this rent in the peritoneum, the needle was plunged through one of the large sinuses, and as a result the operative field was soon obliterated by the bleeding. Hot packs served admirably to control this, and by the time the operation was completed, the bleeding was completely controlled. The patient had a chill and temperature of 102.6 degrees on the first day. The cause of this could not be determined. Temperature returned to normal on the sixth day, and the patient was discharged on the fourteenth day. A living baby weighing 7 pounds was delivered.

Of the 19 cases described, 12 were operated upon at the Bronx Hospital, and the remaining 7 in hospitals outside. Three of the 12 patients were brought to the hospital after prolonged labors at home.

There were 17 primiparæ, 1 secundipara, and 1 quadripara. The secundipara had a flat pelvis, though she had delivered a 7 pound 7 ounce baby spontaneously on a previous occasion. After 26 hours of active labor, the cervix was only two fingers dilated, the membranes intact, temperature 102.6 degrees, while the fetal heart was irregular, varying in rate from 120–200, and the baby was large. Cesarean section was considered the logical method of delivery in the interests of the baby, and the Latzko technique preferable in the interests of the mother. An 8 pound 2 ounce baby, living, and an uneventful recovery of the mother was the result. The quadripara had an ample pelvis. Her labor was conducted at home by her family physician. At the end of 30 hours of labor, during the last 8 of which her membranes were ruptured, the physician attempted a high forceps with the cervix only four fingers dilated. The forceps slipped, the cervix was lacerated, and the patient went into shock. This was an evident case of cephalopelvic disproportion between an ample pelvis and a huge baby (10 pounds 5 ounces), obstetrically mishandled. The patient was removed to the hospital where she was treated for shock. Fear that any attempt at delivery from below, with an already lacerated cervix, would eventuate in a ruptured uterus, prompted the choice of cesarean section (Latzko) in the interests of the mother, a dead baby *in utero* notwithstanding. She made an uneventful recovery.

All pregnancies in this group of cases were at term.

The pelvis was normal in 4 cases, flat in 8 cases, generally contracted flat in 1 case, and funnel in 6 cases. The indications in the normal pelvis group were as follows: fetopelvic dispro-

TABLE IV.—LATZKO OPERATION IN CASES WITH NORMAL PELVIS

Case	Indications for operation			Baby	
	Hours in labor	Hours with ruptured membranes	Complication of labor	Condition	Weight lbs.
5	24	18	Frank breech—floating. Feto-pelvic disproportion. Influenza	Living	8–12
7	30	20	Brow presentation. Cephalo-pelvic disproportion	Living	9–11
9	30	8	High forceps attempt at home on an incompletely dilated cervix. Shock. Cephalo-pelvic disproportion	Still-birth	10–5
10	26	10	Impacted mento-posterior. Cephalo-pelvic disproportion	Living	8–12

portion with frank breech (baby 8 pounds 12 ounces), primipara; cephalopelvic disproportion, brow presentation (baby 9 pounds 11 ounces), primipara; cephalopelvic disproportion, vertex presentation, previous attempt at high forceps with laceration of cervix (baby 10 pounds 5 ounces) quadripara; cephalopelvic disproportion, impacted mentoposterior (baby 8 pounds 12 ounces) primipara (Table IV).

Active labor lasted as little as 4 hours (primipara with funnel pelvis whose membranes had been ruptured for 52 hours without any attempt at engagement), and as high as 72 hours (primipara with funnel pelvis, membranes ruptured for 72 hours, no engagement). The average duration of labor was 32.6 hours.

The membranes were unruptured in only 1 case (secundipara with flat pelvis, previous spontaneous delivery, cephalopelvic disproportion, failing fetal heart, slowly dilating cervix, two finger dilatation after 26 hours of active labor, large baby (8 pounds 2 ounces), mother's temperature 102.6 degrees). At the other extreme, the membranes were ruptured for 72 hours, with a like number of hours in labor, funnel pelvis. The average duration of ruptured membranes was 30.3 hours.

Engagement of the presenting part had not taken place at time of operation in all cases in this group. The presentations were: vertex, 14; brow, 1; face, mentoposterior, 1; and frank breech, 3.

Vaginal examinations will not be summarized because of the unreliability of figures given by family physician while patient was at home or in hospital. Some patients had had no vaginal examinations, rectal examinations having been employed to determine the cervical dilatation, while others had had as high as 6 vaginal examinations.

TABLE V.—INFANT MORTALITY

Case	Indications for operation	Weight of baby lbs.	Autopsy
2	Unsuccessful craniotomy. Impending rupture of uterus. 46 hour labor with 8 hours ruptured membranes	6+	
9	Attempt at high forceps at home on an undilated cervix. Cervical laceration. Shock. Cephalo-pelvic disproportion	10–5	Cerebral hemorrhage

The smallest baby was 6 pounds (craniotomized), and the largest 10 pounds 5 ounces. The average weight was 8 pounds. Of the 19 babies there were only two stillbirths (10.5 per cent). One was a craniotomized baby, the other resulted from a high forceps attempt in the patient's home, and was already dead when patient was brought to the hospital. Autopsy on this baby revealed a cerebral hemorrhage as the cause of death. Among the 17 live births was one whose delivery by high forceps had been attempted by the family physician prior to operation. There were no neonatal deaths (Table V).

The peritoneum was opened in 4 cases. Immediate suture prior to incising the uterus prevented an initial spill. In Case 1 patient developed an exudate in the left broad ligament with an edema of the vulva as a result of lymphatic block, purulent lochia, and temperature for 21 days. She was discharged cured on the twenty-fifth day. Case 10 made an uneventful recovery. In Case 15 both peritoneum and bladder were opened, the latter completely healing by the tenth day. The puerperium was otherwise uneventful. In Case 19 patient had a single chill with temperature of 102.6 degrees on first postoperative day. Puerperium otherwise uneventful (Table II).

There were four bladder injuries. One of these (Case 2) was not directly attributable to the Latzko procedure *per se*. The operation was done on this patient following a 46 hour labor, unsuccessful attempt at craniotomy which was halted with the development of a contraction ring and rupture of the uterus seemed imminent. Catheterization before operation was productive of a bloody urine, showing that trauma to the bladder had already occurred as a result of two factors: (1) a prolonged labor where the bladder was suffering a continued devitalization from the incessant pounding of a hard fetal head on the one hand and a hard resistant pelvis on the other; (2) possible added trauma from the attempts at craniotomy. The first factor seems the major

and more probable one for two reasons: (1) the bladder wall was intact at completion of operation as was evidenced by the absence of leakage when bladder was refilled before closure of the abdominal wall; (2) the appearance of the vesicovaginal fistula for the first time on the sixth day, a condition sometimes recorded following spontaneous delivery. This was the only permanent injury, patient refusing operation for fistula at a later date. The 3 other bladder injuries are attributed to indiscretions in technique. Case 7 was a brow presentation and operation was completed without emptying the bladder, because the catheter had slipped out and no effort was made to replace it. She developed a uterovesical fistula. No doubt in this case the bladder wall was caught in the uterine suture line and ultimately sloughed into the uterine cavity. The use of retention catheter served to bring about spontaneous healing. In Case 11 the bladder was opened with the blunt finger, the injury being attributed to an overdistended bladder. In Case 15, both bladder and peritoneum were opened, the bladder injury here also explained on the basis of overdistention. The authors lay special emphasis to care in avoiding an overfilled bladder. In spite of the fact that dissection was very carefully done with the blunt finger, overdistention of an already devitalized bladder wall made it more susceptible to injury. Both these cases healed spontaneously with the aid of an indwelling catheter (Table III).

In 18 of the 19 cases, the temperature at beginning of operation ranged from as low as 100 to as high as 103 degrees. In 1 case the temperature before operation was not recorded. Temperature lasted for as little as 4 days to as long as 36 days before returning to normal. The average duration of temperature was 12.37 days.

The hospital stay was as low as 10 days to as high as 42 days. The average hospital stay was 16.37 days. When one considers that every one of these cases ran a temperature before operation, and some had prior vaginal manipulation in one form or another, from attempts at forcible dilatation of the cervix to attempts at high forceps, one such patient falling off a delivery room table, the low average duration of temperature of 12.37 days, and the low average hospital stay of 16.37 days are quite gratifying.

There were no maternal deaths. Only 4 cases presented serious postpartum conditions. In Case 1 the peritoneum was opened at operation, and patient developed an exudate in the broad ligament with a secondary lymphatic obstruction resulting in edema of the vulva. She completely recovered after a 25 day hospital stay. Case 2 was the only one left with a permanent injury—a vesicovaginal fistula, which, as has already been pointed out, was due to a devitalization of the vesicovaginal septum with resulting sloughing following a prolonged labor in addition to an unsuccessful attempt at craniotomy. She refused operation for this condition and left the hospital with normal temperature after a 22 day stay. In Case 5, while convalescing from an attack of influenza patient went into labor with an unengaged frank breech. She ran a temperature for 14 days, puerperium being complicated by three attacks of pulmonary embolus. She was discharged on the sixteenth day. In Case 14, the patient, whose temperature was 103.0 at time of operation, had repeated attacks of pulmonary emboli with an infarct of the spleen. After a 42 day hospital stay she was discharged cured.

A most remarkable feature of the Latzko procedure is the little hemorrhage and shock with which it is accompanied. There were no cases of excessive bleeding in this group, and no cases of postoperative shock. This, in spite of the fact that most of these cases started off with a temperature at time of operation, and a good many were in poor condition at the time as a result of either prolonged dehydrating and wearing labors, or previous manipulations and attempts at delivery from below. It was not uncommon to find a patient, immediately after operation, in better condition than she had been at the start of the procedure. This apparent paradox was accounted for by the following factors: (a) patients in shock prior to operation were first treated for the shock with morphine and intravenous glucose; any patient, even though not in shock, who had had a prolonged labor with the slightest evidence of dehydration, was also given an intravenous infusion of 500 to 1,000 cubic centimeters of 5 to 10 per cent glucose solution; (b) the absence of a "peritoneal insult," which is usually occasioned in any of the transperitoneal procedures, by an initial spill of an irritating or frankly infected amniotic fluid, and handling of the intestines. The operation being limited to the lower, thinned-out, almost bloodless uterine segment, avoided opening the huge uterine sinuses. This coupled with the proper conduct of the third stage, aided and abetted by the use of the various oxytocics, served well in the prevention of excessive hemorrhage. Hemorrhage may result from laceration of large sinuses in the broad ligament when the operator strays too far afield (Case 19).

We believe the Latzko operation is indicated in all cases which cannot be delivered by the vaginal

route for a good and valid obstetrical reason, common knowledge to all well trained obstetricians, in addition to which the patient is running a temperature indicative of a potential infection at time of decision in favor of the abdominal route. While not all temperatures are indicative of a potential infection, it seems to us well worth the effort for one to learn the Latzko procedure and apply it in such cases, in order better to insure the chances of recovery for these mothers. It is also indicated in a similar group of cases, who although not running temperature, have been repeatedly examined vaginally, and membranes have been ruptured for a long time.

We do not advise the procedure for every case requiring cesarean section. The operation does entail some technical difficulties which can, we are sure, be overcome by any obstetrician with a sound surgical background and training. The two-flap and classical operations still have their place and are not without their virtues, but they do not afford the added protection for the mother against shock and peritonitis that can be had with the Latzko procedure.

This procedure is not a panacea for all frankly infected cases, where a baby cannot be delivered intact through the vagina. Unless there is an imminent rupture of the uterus, or an already lacerated cervix from previous attempts at delivery from below which would eventuate in a rupture of the uterus were any destructive operation on the fetus attempted, the operation of craniotomy is still the method of choice, on the living baby already injured, if need be. Where a living baby can be procured by the abdominal route in such a frankly infected mother, and, for religious or social reasons a living baby is imperative, the mother notwithstanding, then the Latzko operation holds out the greatest hope of all abdominal methods. No doubt patients delivered by the vaginal route have developed peritonitis by lymphatic extension. Burns reports a case of peritonitis despite the utilization of the Latzko procedure. DeLee's dictum is very appropriate: "Laparotrachelotomy for all but those where infection is suspected, then Latzko's operation, Porro, or craniotomy."

Where previous attempts at delivery from below had already been made, the obstetrician must appraise the possibilities of a baby remaining alive after delivery by the Latzko procedure. For, to what purpose can an initial surgical risk be ventured, when in the end the baby so obtained will either eventuate in one irreparably damaged, or in a neonatal death. If the one doing the operation was the one who had made the vaginal attempt, then he is in a position to know approximately how much trauma to the baby he had already caused. Armed with this knowledge, he is in a better position to arrive at a decision, for or against the risk of operation in the interests of the child. Where the vaginal attempt had been made by an unskilled practitioner, and there are no contra-indications to craniotomy, and it is evident that the baby had already been severely injured, then the destructive operation should be the one of choice in the interests of the mother.

CONCLUSIONS

The Latzko operation is a valuable adjuvant in the armamentarium of every obstetrician. It should not be used promiscuously, but rather in indicated cases only. Its adoption in such indicated cases holds out a definite promise for the reduction of fetal and maternal mortality and morbidity in the "unclean case" group.

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EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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CANCER OF THE STOMACH

HARDLY a situation exists today which challenges the pride of surgery more than that of carcinoma of the stomach. The low percentage of operability when the diagnosis is finally made and the patient is sent for operation, the low percentage of cures, and the high mortality rates of operations for its relief are all too convincing evidences that progress in this field is slow and that there is an opportunity for improvement.

In a paper from this clinic dealing with 195 patients with carcinoma of the stomach, the operability was only 22 per cent. That this is not unusual is evidenced by the fact that in the discussion of a recent paper on this subject read by me before the annual meeting of the Pennsylvania State Cancer Society, a good sized clinic functioning in a rural section where patients do not seek early investigation for gastric discomfort, reported their operability as only 5 per cent and another group as 7 per cent. It will always be true that where the operability is low, the curability will be low and the mortality high.

There are features about carcinoma of the stomach which will make early diagnoses persistently troublesome and a high percentage of cures difficult to attain. The fact that gastric carcinoma tends to diminish gastric acidity rather than increase it, brings about gastric comfort rather than the distress which is associated with high gastric acidity. The type of carcinoma peculiar to the stomach and the caliber of the stomach are such that when obstructive symptoms occur, similar to those warning symptoms present in distal colon cancer, the lesion is frequently so far advanced that it is inoperable. Similarly gross hemorrhage is so rare in carcinoma of the stomach that as a symptom it has almost no warning value. Persistent occult blood in the stools, on the contrary, is a quite consistent feature of carcinoma of the stomach and a diagnostic measure all too infrequently used in patients under suspicion for this lesion.

Add to these features the fact that the stomach has such a rich supply of lymphatics, that it is constantly subjected to powerful peristaltic waves well calculated to disseminate malignant cells, that it has an extremely rich blood supply, and that it is partly hidden under the costal margins, making palpation of early lesions here difficult, and it at once becomes obvious that to make earlier diagnoses of cancer of the stomach is going to require earlier and more frequent X-ray examinations upon relatively intangible evidences and suspicions of the presence of this disease.

One not infrequently hears and reads that the way to improve our results in cancer of

the stomach is to submit all gastric lesions to radical surgery, in order that a carcinoma may not be overlooked and in order that malignant degeneration of the gastric ulcer does not occur. This is, I believe, a wrong attitude, and, were it employed on a large scale, the operative mortality would at least approximate, if not surpass, the percentage of gastric carcinomas which are missed under the plan of pre-operative segregation by frequent X-ray observation while under a short period of hospital observation under medical management. What one has to decide in gastric lesions is, are we dealing with an ulcer which has degenerated into malignancy or with a malignancy which has ulcerated?

More and more gastro-enterologists and surgeons are coming to believe that the percentage of malignant degeneration (if such a condition really exists or the lesion is a malignancy from the start which has ulcerated) is quite low, 5, 6, or 7 per cent. The entire question of the percentage of malignant degeneration of gastric ulcer is open to great possible error, not only in the pre-operative decision but also as to the microscopic diagnosis of malignancy.

What one's attitude should be toward all gastric lesions is that they must all be suspected of malignancy and that unless these patients can be made symptom free by non-operative measures, and all X-ray evidences of the gastric lesion made to disappear completely, then they must fall into the group of probable carcinomas of the stomach, and radical surgery and its attendant risks accepted as justifiable.

What is obviously most needed in carcinoma of the stomach is earlier diagnosis. To accomplish this, the physician must submit his patient, particularly when he is more than 30 years of age, to bismuth X-ray and fluoroscopic examination of the stomach, whenever digestive symptoms persist beyond a week's time. Patients of this age or past must not treat digestive disturbances lasting over a week by means of the various advertised indigestion remedies; they must seek advice with the definite idea in mind that, if indigestion has persisted for more than a week or repeatedly recurs, they should be examined to determine if the lesion is malignant.

As I have said before many times in discussing this subject, if we are to discover gastric cancer earlier, doctor, and patient alike, must understand that in a great majority of cases the X-ray examination for gastric cancer will be negative so that rather than be critical of the expense to which he has been put for X-ray examination, the patient should be thankful that his doctor has taken such precaution, doubly so when the findings are negative but even more appreciative when the doctor's wise forehandedness has made early diagnosis possible and he is thus offered a chance of being cured.

Because so many patients with cancer of the stomach come for operation late, the end-results as relates to cures are poor, and the general attitude on the part of the surgeon and physician toward this lesion is depressingly pessimistic. One has but to look back a few years on carcinoma of the rectum to recall how pessimistic and depressing was the attitude of patient and doctor, how low the operability, and how high the operative mortality. This has now been gratifyingly changed. Of our patients with cancer of the rectum who have had the radical operative procedure, 46 per cent are alive and well over 5 years. The operative mortality has fluctuated with operability from 8 to 12 per cent and the operability has increased in the last 2 years from 54 to 70 per cent.

From the point of view of operability, operative mortality or curability, cancer of

the stomach, for the reasons given herein, will never be as satisfactory a lesion to treat as cancer of the rectum; results can be greatly improved, however, in fact, much of the improvement has already been made.

Many surgeons in this country have acquired experience and skill with the operation of partial gastrectomy, and with the recent advances which have been made in the production and maintenance of anesthesia, a surgeon can do this operation with greater ease for himself and with greater safety for the patient. Improved diagnostic measures are also available for early diagnosis. One pressing need remains, however, to secure improved results in this field, and that is the opportunity to make earlier diagnoses so that the advances in gastric surgery may be applied in the early stages of the lesion when better chances of cure can be offered. All the groundwork for improvement in this field has been accomplished except the education of the public to refrain from self-treatment of indigestion and to submit to early and complete investigation in the presence of gastric distress and discomfort. FRANK H. LAHEY.

THE EVOLUTION OF OUR KNOWLEDGE OF THE THYROID GLAND

HISTORICAL contemplation of medical progress is a fascinating pastime —particularly so when it deals with the physiology and pathology of so extraordinary an organ as the thyroid gland.

In 1806 in a communication entitled, "An Inquiry into the Functions of the Spleen, Liver, and Thyroid Gland," Benjamin Rush remarked, with reference to the greater size of the thyroid in women, "that provision is necessary to guard the female system from the influence of the more numerous causes of irritation and vexation of mind, to which they are exposed, than is the case with the male."

Observations made in 1879 by Gull, of London, marked the beginning of our accurate understanding of the physiology of the thyroid gland. In that year he described a condition to which he applied the term "cretinoid,"—one characterized by dryness of the skin, flabby features, swelling of the hands, and retardation of the mental processes.

In 1883 Theodore Kocher reported results following the removal of the thyroid in a series of 101 patients, the mortality being 12.8 per cent. He discovered subsequently that with 24 patients on whom he had performed *total* thyroidectomy, the final results were uniformly unfavorable. These patients rapidly developed symptoms similar to those presented by the myxedematous patients described earlier by Gull. Kocher described the condition by the term "cachexia strumipriva."

Experimental work performed by Schiff a year later revealed that total thyroidectomy performed on dogs not only proved fatal, but that prior to death tetany became a conspicuous feature. The credit for first suggesting that loss of thyroid function is the common cause of cretinism, myxedema, and cachexia strumipriva belongs to Sir Felix Semon, of London, and by 1880 over 270 papers on the subject had appeared.

In 1891 Murray prepared a glycerol extract from sheep thyroid which he administered subcutaneously to a woman with myxedema; a dramatic change occurred in the patient's condition. In 1882 Hadden had noticed that in myxedema there was a diminution in the excretion of urea, leading Magnus-Levy of Strassburg in 1895 to suggest that alterations in urea output clearly pointed to altered metabolism; as a result, he was prompted to investigate the effects of thyroid extirpation on gas exchange and respiratory metabolism, thus

laying the foundation of a knowledge of the chief function of the thyroid gland. Magnus-Levy noticed that, in Graves' disease, there was a striking increase in oxygen consumption —the first laboratory demonstration that exophthalmic goiter involved abnormal activity of the gland and that the essential function of the organ was to regulate bodily metabolism and to maintain it at an optimum level.

In the same year, in an attempt to produce a highly concentrated preparation from the thyroid with more potent physiological activities, Baumann established a fact, long suspected, that the gland normally contained a high percentage of iodine.

In 1886 Mobius, of Leipzig, suggested that a pathological alteration in the thyroid gland was the primary factor in the causation of Graves' disease. Mobius, and later Plummer, advanced the theory that the syndrome presented by the patient with exophthalmic goiter was due not only to oversecretion, but to abnormal secretion as well.

Oswald, of Zurich, in 1899, studied the protein constituents of the thyroid, finding that goiters in which the increased size was due to cellular hyperplasia and in which the colloid was reduced—as occurs in Graves' disease—were iodine free; while in colloid goiter, great quantities of iodine were present.

Coindet was the first to use iodine in the treatment of goiter, although the cures following the administration of burned sea sponges had for over 500 years depended on this element.

Pliny was aware of the occurrence of goiter in pigs. Writing in 1271, Marco Polo says of the people of one of the countries he visited: "They are in general afflicted with tumors in the throat occasioned by the nature of the water which they drink." While painting the roof of the Sistine Chapel, Michelangelo penned a sonnet to a friend which begins with these words:

> I've grown a goitre by dwelling in this den
> As cats from stagnant streams in Lombardy
> Or in what other land they hap to be.

As early as 1794 treatises, devoted entirely to the subject of goiter and cretinism, began to appear, the first from the pen of Gauthier.

In 1830 Prevost, of Geneva, argued that goiter was an iodine deficiency disease and that the fault was in the water supply; while about the same time Boussing Ault was led by his work in the Andes to recommend the official sale of iodine as a prophylactic measure. In 1852 Cheetin suggested that the water supplies in goiterous districts should be enriched with iodine.

In 1907 Marine demonstrated that 90 per cent of the dogs in the city of Cleveland showed some degree of enlargement. He also showed that, as soon as the glandular iodine fell below normal, hyperplasia became detectable and that the amounts of stainable colloid varied inversely with the hyperplasia and directly with the iodine content.

In 1919 Kendall, of the Mayo Clinic, succeeded in obtaining a crystalline substance containing 65 per cent of iodine which exhibited the physiological effects associated with the thyroid gland and to which he applied the name "thyroxin."

In 1926 the problem was taken up by Harrington, of the University of London, whose mode of attack began with hydrolysis of the gland tissue with dilute barium hydroxide. In 1927 thyroxin was synthesized by Harrington and Barger.

The influence of the thyroid on growth is striking. In 1914 Gudernatsch utilizing tadpoles demonstrated the remarkable effect of the gland on this process.

The direct effect of thyroxin on the heart muscle has lately been demonstrated. The

recent experiments of Lewis and MacEachern prove that the tachycardia of thyroxin treated rabbits continues for hours even after the heart has been transferred to Ringer's or Locke's solution.

Smith and Allen have recently demonstrated that the anterior lobe of the pituitary is truly the controlling influence in the functional state of many organs, particularly the thyroid, sex glands, and adrenals. Sufficient work has appeared to prove conclusively that the thyroid may be stimulated by it, and, in all likelihood, by this agent only.

More recently it has been noted that injections of estrogenic substances induce definite histological changes in the thyroid epithelium. In the complex interrelationships existing between the hormones and the endocrine system it has been suggested, notably by Bodansky, that thyroxin influences the hypoglycemic action of insulin.

Marine and Baumann, who have for years studied the thyroid and suprarenal relationship, conclude that the hormone from these glands, acting through the anterior pituitary lobes have definite influences, not only on the thyroid gland, but on all endocrine tissues.

We are finally justified in accepting with Marine the conclusion that simple goiter is a manifestation of a work, or compensatory hypertrophy, which is primarily produced by the thyrotropic hormone of the anterior pituitary in response to the normal or abnormal demand of the organism for increased thyroxin largely influenced by the need of the body for iodine.

These are a few of the thousands of landmarks in our far flung journey of thyroid exploration and discovery.

HAROLD L. FOSS.

LANDMARKS IN SURGERY

ABRAHAM COLLES

His Outstanding Contribution to Surgical Anatomy

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HISTORY tells us that a comparatively high state of civilization existed in Ireland during the early centuries of the Christian era. It is reasonable to infer, therefore, that these ancient Irish were not ignorant of the principles and the practice of medicine. In the centuries immediately preceding the nineteenth, however, Ireland was a most unhappy country. The population was small, poverty was the rule, and only in Dublin were there offered opportunities for higher education. Strife was rampant and there was little indeed to encourage men of ability to study and practice medicine. But with the years that usher in our story a new medical era dawned. The College of Physicians and the College of Surgeons were both granted charters, and medical teaching at the universities in Dublin was given a needed impetus. About the time this movement was getting well under way, Abraham Colles was born. His biographers give us July 23, 1773, as the date, and the place, Millmount, Kilkenny, where his family had settled two generations before. His grandfather had been a medical man, but his father operated an extensive quarry of the famous Kilkenny marble.

The education of young Abraham was the best available in the vicinity of Kilkenny, and, when the time came for him to enter the university, he was well prepared. Legend has it that he became interested in the study of medicine through the finding of an old book of anatomy washed on his father's property by the flood waters of the river Nore, which coursed through the Colles estate. The owner, a local doctor, on the return of the book, noticed the boy's interest in the subject and encouraged him, with the result that on completion of his basic schooling, in 1790, he decided to go to Dublin for the first part of his university work.

Not being a brilliant student, Colles gathered no academic laurels. He was, however, an intensely interested student, and his assiduous application won for him an apprenticeship to the resident surgeon in Steevens Hospital, Dublin. It was in this position that the traits which were to characterize his later work found the first abundant outlet. With plentiful material and no other interest, he developed the power of simple observation and the copious case notes he left at the end of his service are still in existence. It was this observation of apparently insignificant signs that was to lend his name to one of the most common, yet least understood, of surgical lesions. It may have been that he was also activated in his work during his apprenticeship by the desire to elevate himself to the resident's post when he completed his schooling. That the residency at such a hospital was a choice post is appreciated when we recall to mind that as such he could teach privately and thus add to the meager stipend which the beginner in Dublin could hope to earn.

After 5 years at the university in Dublin he chose Edinburgh as the school from which he was to receive his degree in medicine. This he obtained after two sessions of work, and was then confronted with the problem of where to practice. He wanted to return to Dublin, where he had made friends and where relatives lived, but neither group could offer any special assistance in developing a practice. Therefore he decided to go to London where he might visit the schools and hospitals and, perchance, light upon some opportunity. This opportunity came, not in lucrative form, but in a way to develop himself in anatomy. Sir Astley Cooper, destined to be the leading English surgeon of his time, was then a young man engaged in the study of the anatomy of hernia. Colles assisted him in this work and in doing so conceived the idea of later publishing his own *Treatise on Surgical Anatomy* for which work we are particularly indebted. He constantly decried the older methods of teaching anatomy, and insisted that it should be the principal fundamental science in the training of a surgeon. The method of teaching anatomy by systems, with no correlation, he deplored, and more so the fact that,

Abraham Colles
1773–1843

Diagram of Colles' fracture

given in the light of an abstract science, it could not and did not give the student or the surgeon the opportunity to apply the little he might know to the work of the operating room. In the opening pages of his treatise he devotes considerable space to such a thought, and says, among other things:

> The student who has been employed in acquiring an anatomical knowledge of the different divisions or systems of the human body has but encountered all the difficulties, without securing any of the benefits. For such a plan of study can neither enable him to form a perfect idea of the structure of any part of the body, nor can these partial and detached views of the anatomy in any degree qualify him to perform a surgical operation. The study of anatomy too generally ends at that point where it begins to be useful.

In 1797, Colles left London, having accomplished two things—developing the friendship of Cooper, and laying the groundwork of a thorough knowledge of anatomy. He returned to Dublin and to two years of distinct unhappiness. His start was anything but promising, and it was only with the utmost courage that he was able to keep in mind the goal he had set for himself. Army life and that of the provinces tempted him, but in 1799 he returned to Steevens Hospital at his own solicitation, this time as resident surgeon, a post which, during his apprentice years, it would have been most natural for him to covet.

This appointment marked the turning point in his career and the beginning of his phenomenal ascent to the leadership of surgery in Ireland. At Steevens was available abundant material of clinical, operative, and autopsy variety. The latter still presented the medical profession with many difficulties, but the authorities were beginning to realize the importance of this field to medical progress, and it was rare that grave robbing and other illegal methods of obtaining postmortem material had to be resorted to. Colles rapidly became known as a promising surgeon, not only because of his manual dexerity but because of his diagnostic skill and judgment. The private classes in anatomy and surgery which he instituted at the beginning of his residency, flourished, and he added to his other qualifications that of a thorough and inspiring teacher. His private practice developed slowly but steadily, and the records which he kept show that after 3 years his income reached between 400 and 500 pounds. This increased rapidly as his position in Dublin advanced, and in the prime years of his career his fees never aggregated less than 5,000 pounds.

The next important step in the rise of Colles, after his appointment to the surgical residency at Steevens, was his elevation to the chair of anatomy and surgery at the Royal College of Surgeons in Ireland, a post he was to hold jointly with Mr. Dease. This advancement came shortly after the Royal College obtained his services as a lecturer, and it was in such capacity that he was able to instill in his colleagues and students his outstanding zeal, patience, and inquisitiveness. The desire for professional education increased markedly and he became the most popular teacher in the city. With the increase in the number of students, there followed an increase in the productiveness of the various units of the school and hospital with which he was associated. Research departments, of course, were not endowed and organized as we see them now, and only a few of those proved concepts which have revolutionized medical thought were known at that time. For this reason the investigative work of Colles and his associates was almost entirely clinical in nature. Because of the absence of precise diagnostic procedures, their most effective weapon was the power of observation. This Colles practiced, and this he taught during the 32 years of his professorship. To see, to feel, to judge, and to act; to be the first to admit one's mistakes, both to one's self and to one's colleagues. These were the fundamental precepts in the teachings of this man. Little wonder, then, that at one time the Royal College of Surgeons in Ireland counted more pupils than any other similar institution in Great Britain. Figures, too, are convincing in this regard, for we find that the number of medical students in Dublin in 1836 was nearly 1,000, while in 1800, when Colles himself became a member of the College, but 60 was the yearly average. This fact may well have been but one expression of the cultural advance Ireland made in this period, but if any one man in Irish medicine personified that advance, that man was Abraham Colles.

The paucity of Colles' writings is to be regretted. His critics might, with some justification, hold that a man with such opportunities to observe, to operate, and to record his successes and failures, is in duty bound to enlighten his less fortunate confrères by writing and speaking. They, in turn, might apply his conclusions to their own advantage and to the advantage of their patients. His work in surgical anatomy, never completed; the studies he made in the treatment of syphilis; his contribution to the surgery of vascular disease, and, most important, his observations on fractures of the radius, are all that remain of his works in printed form. The explanation for this probably can be found by a study of his character. He was eminently retiring and avoided publicity of any kind. In his recorded lectures and papers is found an absence of all eloquence and show. He abhorred statements loosely made, without adequate foundation, and in his classes he took every opportunity to repress premature theorizing on the part of his pupils. He took the view that medical practice would always have in it an element of speculation, the success of which would depend largely upon the individual. Facts, one upon the other, made for progress, and these alone should be passed on for future use. He was fully aware that the theories of one generation were cast aside by the

facts of another. It is quite easy to see how a man whose writings suggest such thoughts would be extremely cautious about what he advocated.

In 1807 Colles married the daughter of a Galway rector and took a small house on Stephens Green in Dublin. As his family grew he found it necessary to move to a larger home in the same square, which he occupied for the remainder of his life.

In the quiet study of this big house, Colles, in 1814, assembled the data he had gathered about a certain injury to the wrist. The exact nature of this injury, a common one, was in doubt, and there was no unanimity of opinion about it among the surgeons of that period. It was agreed that the lesion was usually the direct result of a fall upon the outstretched hand, the hand being used to lessen the force of the impact on the body. The most common belief, however, was that a radiocarpal dislocation had taken place. Among the adherents to this theory we have no less a light than Sir Astley Cooper, who said—"I have seen this accident frequently and at first did not understand the real nature of the injury. Indeed, dissection alone taught me its real character . . . that there is evident projection of the radius and ulna on the dorsal surface, and of the carpus on the palmar surface of the forearm." Colles was unfortunate in that he had had no opportunity to inspect openly after death the state of the bones about such a wrist. His conclusions, which differed sharply from the thought current at the time, were based entirely on the appearance of the wrist and forearm, together with what he could determine by palpation. This study "On the Fracture of the Carpal Extremity of the Radius" was published in the *Edinburgh Medical and Surgical Journal*, vol. 10, 1814, and has served to make the name of Colles renowned wherever surgery is practiced. As Professor R. W. Smith says in his *Treatise on Fractures in the Vicinity of Joints:* "If we except the observations of Petit and Pouteau, there are no earlier accounts of this injury, and the characteristic deformity accompanying it, worth being referred to."

Whether Colles continued his studies of this lesion and corroborated his impressions with subsequent autopsy findings, we do not know. We do know, however, that many others did, and a voluminous literature has been developed on this subject. The original contribution of this man remains through all the subsequent advances, a landmark in surgery, and a firm block from which others spring in investigations in this field. Of course, finer points have been drawn in the morbid changes which take place in this injury; variations in the displacement have been suggested and defined, and other names have been appropriately added to these variations; refinements in treatment have been adopted, and with the advent of the X-ray and the popularization of physical therapy, certainly the convalescence has been shortened. But, with all these things, we might in retrospect wonder if our results are correspondingly better than those of Colles, better than those of the man who looked at the patient and not at a film, whose deft fingers gently touched ecchymotic and edematous tissues in a diagnostic maneuver many of us are inclined to neglect, and who, by this combination of remarkably developed powers, was able to say: "This simple method of examination enabled me to ascertain that the symptoms actually arose from a fracture." It is true that he placed the site of the fracture a fraction of an inch too high, but who would not agree with Smith, who says, "It must be admitted that he conjectured its anatomical characteristics with tolerable accuracy."

To us, who had no personal contact with him, he remains the outstanding Irish surgeon of his time, and since we must necessarily appreciate him by his own writing and that about him by his contemporaries, this work on the radius remains the bright light of his professional career. To his patients, students, and colleagues, however, this work no doubt would pale into insignificance when compared with the man himself. It was with the deepest regret that these friends persuaded him to give up his work at the school and the hospital in 1841, because of ill health. He did this reluctantly, but kept his private practice as best he could in the two unhappy years that followed. Then, sensing the end, he continued to be up and about until his swollen extremities and shortness of breath forced him to bed for the last time.

In the few remaining days he might have looked back with pardonable pride upon a most useful and enviable life—that of a beloved father, eminent teacher, skilful surgeon, twice president of the Royal College of Surgeons, and the distinction of having declined a baronetcy because it was offered to honor him as a man, and not as a representative of the medical profession in Ireland. Could he have looked ahead he would have seen a public funeral and a vast concourse of friends and representatives from all the kingdom in the procession; he would have noted the cessation of activity in the medical schools of Ireland, and later the preservation of his likeness on canvas and in marble in the halls of the Royal College. But the inevitable increase of uremic toxins would have terminated these introspections, for shortly, painlessly, and in a deep sleep, he died.

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CORRESPONDENCE

THE EFFECT OF VIOSTEROL IN JAUNDICE

To the Editor: The paper published by McNealy, Shapiro, and Melnick in the April, 1935, number of SURGERY, GYNECOLOGY AND OBSTETRICS, was presented as a study of the effect of viosterol in jaundice. No particular attention was paid in this study to the general mortality and morbidity statistics at Cook County Hospital, except as it concerned the patients studied. From the nature of the work, we could use only those patients who were in the hospital long enough to have complete bleeding time studies and to receive 1 or 2 weeks of pre-operative preparation. This automatically excluded all patients operated upon as emergencies or after only 1, 2, or 3 days of hospitalization. The patients used, however, were unselected as to age, sex, race, or general condition, also unselected in the sense that the control and definitive patients were taken from the same group.

A subsidiary study of all the gall-bladder and common duct cases operated upon during the period revealed a striking and foreboding difference between the mortality in the group of elective, leisurely and carefully handled cases to which our study was of necessity limited, and the group of desperate emergencies who were hastily operated upon without precise diagnosis and preparation. In our original study hardly any of this latter group was seen by us because they were rushed through before they could be picked up in our rounds or before study and treatment could be gotten under way.

Among 254 elective gall-bladder operations there were only 4 deaths, a mortality of less than 2 per cent. In the emergency group, the acute empyemas of the gall bladder showed a mortality of 24 per cent, the acute pancreatitis cases a mortality of 50 per cent, and in the misdiagnoses operated on under the diagnosis of gall-bladder disease and which included cases of coronary thrombosis, empyema, subphrenic abscess, perforative peritonitis from gangrenous appendices and peptic ulcers, etc., the mortality was in the neighborhood of 75 per cent.

In the common duct cases were included not only those patients in whom stones were removed from the common duct at operation, but also those with a history of recurrent jaundice or intermittent hepatic fever and those in whom the common duct was explored even though stones were not found. Here too among 63 elective, cautiously and completely studied cases there were 7 deaths, a mortality of 11 per cent. Hasty operating in this group was more rarely indulged in, yet in 9 desperate cases in which operation was done there were 7 deaths, a mortality of 77 per cent. Added together, there was an average mortality in this group of 20 per cent.

It is very likely that several of the patients who were operated upon as emergencies would have died without operation. Yet these statistics firmly reemphasize that in gall-bladder and common duct surgery, calm deliberation, careful study, and adequate preparation are essential.

MCNEALY, SHAPIRO, AND MELNICK.
R. W. MCNEALY

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE second volume on *Pneumonokonioses (Silicosis) Literature and Laws*[1] up to 1935 is a text, while the first volume, which appeared over a year ago, was more a reference compilation of the history of diseases or afflictions pertaining to silicious or non-silicious dusts. Many attempts have been made to define silicosis. The definition given by F. S. Kellogg in an address before the American Bar Association is noteworthy. Regardless of the definition of silicosis, most of the proved causes of dust in any form have to be found at autopsy.

Those of us who, from association, have been on the firing line during the past several years, with suits amounting to more than $150,000,000 in Illinois, will appreciate what a gift this second book really is. E. R. LeCount has stated in the "Foreword," it is not only opportune; it is overdue. The storm of lawsuits reached us and were being tried before this Book II summary was published.

We spent nights searching medical literature for something tangible and authentic to assist attorneys trying these cases. If Book II had been available, we would not have had so many reference worries. The subject index includes abstracts on anthrocosis; asbestosis; cement dust; dust collectors; dust control; dust counts; dust masks; exhaust ventilation devices (including dust fans); the subject of fibrosis; granite cutters disease; gypsum, hematite; occupational disease acts of many States; International Labor conference of 1934; Johannesburg conference; Jones-sericite theory; lung pathology; lung silica content; silica in normal lungs; marble dust; miner's phthisis. There are also abstracts on the National Bureau of Casualty and Surety Underwriters conference; pulmonary heart disease; quartz; different types of respirators; roentgenograms' interpretation; sandblasting industry; Saranac Lake laboratory; siderosis; silico-tuberculosis; silicosis awards; silicosis diagnoses; silicosis postmortem; silicosis racket; silicosis in urine; tuberculosis relationship; Wisconsin dust code; and many other subjects condensed so that one familiar with these troublesome issues can determine easily if it is necessary to review the original articles for a more elaborate picture of the case in question.

The Laws in the United States pertaining to occupational diseases are well abstracted. The last word given by each one of the States having laws covering disability payments for occupational disease is given. C. F. Sharkey tells of legislation in the United States, stating that compensation laws are in operation in 44 of the 48 states. Only 12 states compensate for occupational disease. The Wisconsin Dust Code of allowable dust standards is quoted:

> Dust containing less than 35 per cent free silica in a cubic foot of air is allowed to be present in a quantity of 15 million countable particles under 10 microns in longest dimension. As the silica percentage increases, the number of dust particles allowed to be present, decreases. Pure silica (SiO_2) is allowed to be present in a quantity of 5,250,000. . . . The first condition for the occurrence of a silicotic process is, according to the present investigation, that the inhaled dust contains a large percentage of silicon dioxide and that it is possible for this dust to gain an entry into the alveoli, provided, that is, that the particles of dust are not more than 10 microns in size. After inhalation the silicious dust chemically or coloido-chemically acts on the lung tissues, causing them to react resulting in the formation of typical silicotic nodules.

Roentgenological findings, necessarily technical, of great value to all, are well presented by Dr. H. P. Sampson, whose experience in dust fibrosis is greater, probably than that of any other X-ray authority in the United States.

The discussion of the sericite theory is well given by Professor Haldane and Professor Kettle. Much has been written about the mineral, sericite, and the extent of damage it causes to lung tissue.

There is one item lacking in the digest of literature for 1934 and that is, reference to non-disabling silicosis or any form of dusty lung disease; many employees have silicotic nodules in the lungs but this condition does not constitute disability.

In Book II, the authors have brought the subject matter down to the present in an excellent manner. One can unhesitatingly endorse the book as outstanding; to be highly recommended for doctors, laboratory workers, claim departments of insurance companies, and lawyers, because it summarizes practically everything that has happened during 1934 in civilized countries throughout the world concerning pneumonokonioses. ROY KUHN.

IN making a translation of the German edition of *William Conrad Roentgen*[2] Glasser has incorporated minor corrections and revisions. Roentgen, a physicist, decided in October of the year 1895 to make some experiments with cathode rays. It was during the course of these experiments that, on a Friday evening, November 8, 1895, he made the

[1] THE PNEUMONOKONIOSES (SILICOSIS) LITERATURE AND LAWS OF 1934. INTERNATIONAL ABSTRACTS, EXTRACTS AND REVIEWS OF THE PNEUMONOKONIOSES AND THEIR ASSOCIATED DISEASES AND SUBJECTS. By George G. Davis, M.D., Ella M. Salmonsen, and Joseph L. Earlywine. Chicago: Chicago Medical Press (Not Inc.), 1935.

[2] WILHELM CONRAD ROENTGEN AND THE EARLY HISTORY OF THE ROENTGEN RAYS. By Otto Glasser. With a Chapter "Personal Reminiscences of W. C. Roentgen" by Margret Boveri. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1934.

observation which proved to be so significant. After examining and testing all details, he published his observations in a "Preliminary Communication" at the end of December, 1895. Few announcements of scientific discoveries have received such rapid and widespread publicity. In a few weeks his communication had been translated into all languages and had become known throughout the world.

The application of the X-ray to medicine was immediately recognized, and the field has grown by leaps and bounds. The author has covered the use of X-ray not only in medicine, but also in non-medical fields.

Interest in the volume is greatly enhanced by the chapter on personal reminiscences by Margret Boveri. The chapter teems with interesting facts concerning Roentgen's youth, education, and character.

The volume should be of interest not only to the radiologist but to all interested in medical and scientific history. EARL E. BARTH.

AS the title indicates, Hoyer's book[1] is a comprehensive review of the anatomy of the lymphatic system as it exists in all the vertebrate groups from the lowest fishes to man. Anyone interested in such details can find in this compilation succinct summarizations and competent bibliographies. At the end is a brief recapitulation of some of the most pertinent comparative facts and an instructive, schematic diagram of the lymphatic plan throughout the vertebrate series. To those interested primarily in the medical sciences, the recent volume of Rouvière (1932) will prove more generally useful.

L. B. AREY.

[1] MÉMOIRES DE L'ACADÉMIE POLONAISE DES SCIENCES ET DES LETTRES. CLASSE DE MÉDICINE 1934. DAS LYMPHGEFÄSSSYSTEM DER WIRBELTIERE VOM STANDPUNKTE DER VERGLEICHENDEN ANATOMIE. By Henryk Hoyer. Cracovie: Imprimerie de L'Université, 1934.

THE larger part of Safian's profusely illustrated volume[2] of 200 pages is devoted to hypertrophy of the nose and its constituent parts and to saddle nose. Although the author mentions the use of cartilage transplants in the treatment of the latter condition he prefers to use ivory, and does not indicate how cartilage transplants can be measured for or adapted to an individual case. He simply states "the transplant is shaped with a sharp scalpel to fit the defect."

Comparatively little space is given to such problems as the broad and asymmetrical nostril with lateral displacement of the ala, deformities of the nose associated with extensive loss of tissue, and complete restoration of the nose. No mention is made of the deformities of the nose associated with retraction of the upper lip; and very little space is given to the treatment of recent injuries.

There is abundant pictorial evidence to attest the author's skill in the treatment of "hump nose," of hypertrophy of the bony and cartilaginous framework, and of the tip of the nose; and the results he has obtained in the treatment of these conditions are admirable. One wishes there were more detailed information for the student who is concerned with the many other problems involved in the surgical treatment of nasal deformities.

SUMNER L. KOCH.

[2] HOEBER'S SURGICAL MONOGRAPHS. CORRECTIVE RHINOPLASTIC SURGERY. By Joseph Safian, M.D. New York: Paul B. Hoeber, Inc., 1935.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

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SURGERY, GYNECOLOGY AND OBSTETRICS

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TREATMENT OF PEPTIC ULCER BASED ON PHYSIOLOGICAL PRINCIPLES[1]

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ALTHOUGH considerable progress has been made in gastric surgery in the past two decades, the treatment of chronic peptic ulceration still is not wholly satisfactory. Too frequently the physician's attention is directed to the ulcerative lesion in the stomach or duodenum without his realization that the local lesion is merely a symptom of a generalized disorder. The treatment of the ulcer alone is almost as illogical as the treatment of pyrexia with antipyretics. Unless the underlying factors which are responsible for the predominating symptom in each instance are corrected, the results of therapy are likely to be unsuccessful.

In order to treat a patient with peptic ulceration rationally, it is important to have some conception of its cause. The factors which are responsible for peptic ulceration may be divided into two groups, in one of which are the factors which cannot be controlled, that is, are not amenable to treatment, and in the other of which are the factors which can be influenced by therapy and the correction of which may result in amelioration of symptoms and possibly a cure. The uncontrollable factors which in reality are predisposing ones are: (1) *tissue susceptibility* and (2) *constitutional predisposition*. By tissue susceptibility is meant the vulnerability of certain portions of the gastro-intestinal tract to peptic ulceration, namely: the lesser curvature of the stomach (*magenstrasse*), the duodenal cap, the jejunum, and other portions of the intestinal tract subjected to acid gastric secretion, as in Meckel's diverticulum containing islands of gastric mucosa. The predisposing factor, "tissue susceptibility," is present in all individuals, but peptic ulcer probably never occurs unless other factors are also operative. "Tissue susceptibility" to peptic ulceration is an inherent quality, which cannot be altered, but the surgeon can refrain from performing operative procedures which will subject abnormally susceptible portions of the intestinal tract to the acid gastric chyme. Matthews and Dragstedt showed that the susceptibility of the intestinal tract to acid gastric chyme increases proportionately with the aboral distance from the pylorus. The susceptibility of the intestinal tract to peptic digestion is illustrated by the occurrence of jejunal ulcers following gastrojejunostomy and the development of peptic ulcers in Meckel's diverticula which contain gastric mucosa. We have been able to corroborate Matthews and Dragstedt's experimental work concerning the susceptibility of the intestinal mucosa to acid gastric secretion. Although trauma by food impingement against the lesser curvature of the stomach has been blamed for the development of ulcers in this area, we believe from

[1]Presented before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

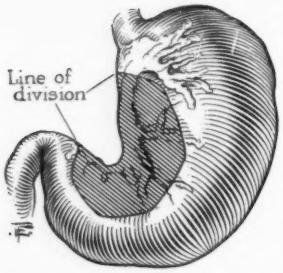

Fig. 1. Diagrammatic drawing showing that portion of the stomach remaining after extirpation of the lesser curvature. No ulcers developed in this group of animals, although in a similar group of animals in which the greater curvature was extirpated leaving the lesser curvature intact, the incidence of ulceration was 63.8 per cent. (After Ochsner, Gage, and Hosoi. Arch. Surg., in press.)

our experimental observations that there is an additional and more important inherent factor which is independent of trauma. In our experiments (33, 67) which consisted of the extirpation of the lesser and greater curvatures of the stomach, respectively, the incidence of ulceration in the two groups of experiments varied considerably. In those cases in which the lesser curvature remained after extirpation of the greater curvature, the incidence of ulceration was high (63.6 per cent) (Fig. 1), whereas in those in which the greater curvature remained after the removal of the lesser curvature no ulcers developed. Extirpation of the greater curvature, which in reality is a fundusectomy, as suggested by Connell, resulted in a much higher incidence of ulceration than in animals with the lesser curvature removed, probably because of the greater susceptibility of the lesser curvature to ulceration. Watson found that, whereas definite reductions in total and free acidity were obtained immediately after extensive fundic resections in dogs, the decrease was less marked after 4 months. We believe, because of the results of this investigation, that although theoretically and actually fundusectomy results in reduction of gastric acidity, which reduction is not permanent, however, the operation is not justified because the lesser curvature being more susceptible to ulceration is much more vulnerable than is the fundus. These experiments clearly demonstrate the importance of "tissue susceptibility."

The "constitutional predisposition" (ulcer diathesis) is probably one of the most important factors as regards the development of peptic ulceration. Although it is difficult to define ulcer diathesis, it hardly can be denied by one with considerable clinical experience with peptic ulcer patients that "constitutional predisposition" does exist. Whether it consists of a peculiar arrangement of the capillaries of the mucosa of the stomach with the production of large submucous plexuses in the subepithelial layers (vasoneurotic diathesis), as demonstrated by Duschl and by Mueller and Heimberger, or of increased irritability of the parasympathetic nerves (vagatonia), as suggested by von Bergmann, or of overactivity of the sympathico-adrenal system, as proposed by Crile, cannot be definitely proved. Draper, Dunn, and Seegal believe that ulcer patients have characteristic anthropometric relations which they designate as "ulcer constitution." The relative importance of "constitutional predisposition" varies in different individuals. Judd and Waldron (49) state that the predisposition to ulceration is especially marked in patients with duodenal ulcer and less so in gastric ulcer patients. Hurst (43) believes that the type of peptic ulcer is dependent upon the habitus of the patient. The patient with a high, short, rapidly emptying stomach (hypersthenic gastric constitution) with hyperchlorhydria and with little or no mucus in the stomach, usually has duodenal ulcer, whereas the patient with a long, slowly emptying fish hook type of stomach (hyposthenic gastric constitution) with hypochlorhydria frequently has a gastric ulcer. Morley, in a series of 250 normal individuals, found the stomachs in 7.8 per cent hypersthenic, in 44.4 per cent sthenic, in 46.8 per cent hyposthenic, and in one per cent asthenic. In 50 cases with duodenal ulcer the percentages were 5.5, 44.4, and 50.3, respectively. In a correlation between the gastric acidity values and the types of stomach, it was found in this investigation that the acidity was lowest in the asthenic types and highest in the hypersthenic types. Cushing has emphasized the importance of association of cerebral lesions and peptic ulceration and concludes: "it may easily be that highly strung persons, who incline to

the form of nervous instability classified as parasympathetic (vagatonic), through emotion or repressed emotion, incidental to continued worry and anxiety and heavy responsibility, combined with other factors, such as irregular meals and excessive use of tobacco, are particularly prone to have chronic digestive disturbances with hyperacidity often leading to ulcer effects wholly comparable to those acutely produced by irritative lesions experimentally made anywhere in the course of the parasympathetic system from tuberal center to its vagal terminals." The importance of psychic strain as an etiological factor in peptic ulcer is illustrated by Rivers' findings in 200 specialists in medicine. Twenty per cent of them had definite peptic ulceration (usually duodenal) and at least an additional 20 per cent admitted taking alkalies at intervals. These findings are even more significant when contrasted with the findings in a group of negro patients in none of whom was there any evidence of peptic ulcer. Wilkie refers to the individual with "constitutional predisposition" as an "ulcer former," and Yates states that those susceptible to the disease can develop chronic gastroduodenal ulcer. Possibly as the result of the constitutional neuromuscular imbalance—vagatonia of Bergmann (10) or sympathico-adrenal hyperirritability of Crile (16)—there frequently occurs spasm or lack of relaxation—achalasia, Hurst (42)—of the pyloric sphincter. Whether the condition is a spasm of the pyloric sphincter (pylorospasm) as contended by Ivy (45), Finney (29), Judd and Waldron (49), and Yates (85) or absence of normal relaxation (achalasia) as suggested by Hurst (42), Miller (61), Martin and Burden (56) makes little difference because, in both, gastric retention results.

If the above premise is correct concerning the predisposing factors, viz., "ulcer diathesis" and "tissue susceptibility," little can be accomplished as regards the correction of these inherent qualities aside from avoiding those operations which will subject a highly susceptible portion of the intestinal tract to the acid gastric chyme. Although as mentioned above "tissue susceptibility" to peptic ulceration is present in all individuals, constitutional predisposition occurs comparatively less frequently. The concomitant occurrence of these two predisposing factors does not necessarily result in chronic peptic ulceration, however, because unless there are additional exciting or precipitating factors, ulceration probably never occurs. The precipitating factors which are controllable, that is, are amenable to therapy, are *hypersecretion and hyperacidity, focal infections*, and *gastric trauma*. Hypersecretion and hyperacidity occur normally in many individuals. Rehfuss and Hawk found that 40 per cent of normal individuals had gastric hypersecretion, and Bennett and Ryle found persistent hyperchlorhydria in 10 per cent of 100 normal persons. The abnormal accumulation of gastric juice may be due to two factors which accentuate each other. As the result of pylorospasm or achalasia, there is retention of gastric secretions which, by causing gastric distention, stimulates further secretion (Meek), thus setting up a vicious circle. Although hypersecretion may be of little or no significance during the digestive period when food is in the stomach, it is a real danger when present in the fasting stomach as shown by Winkelstein (82). Focal infections are important etiological agents in peptic ulcer as demonstrated by the work of Rosenow and his associates (66). Focal infections may produce specific inflammatory lesions in the stomach wall, as suggested by Rosenow, by Konjetzny, by Orator and Metzler, and by Puhl, or when within the abdomen they reflexly can produce pylorospasm. In the former instance the focal infection plays a more or less specific rôle, whereas in the latter its action is entirely nonspecific. A factor which may or may not be of importance is trauma to the stomach during digestion. Aschoff stressed the danger of trauma to the stomach along the gastric pathway, over which area the gastric mucosa is different from that in other portions of the stomach. Mann and Williamson believe that the mechanical impingement of the acid gastric chyme against the lesser curvature of the stomach and the duodenal cap is of etiological importance in the development of peptic ulcer. Because ulcers occurred in the jejunum just beyond the gastrojejunal anastomosis in animals with the "duodenal drainage operation," these investigators considered the ulcer-

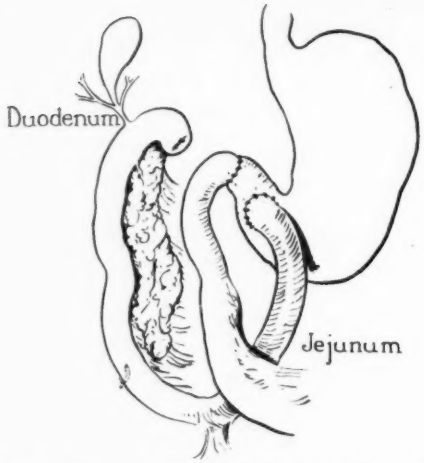

Fig. 2. Diagrammatic drawing showing modification of McCann operation with the duodenum anastomosed to the stomach just proximal to the gastrojejunal anastomosis. In this way the alkaline duodenal secretions are emptied into the stomach just proximal to the anastomosis. No ulcers developed, demonstrating that trauma plays an insignificant rôle. (After Graves. Arch. Surg., 1935, 30: 833.)

ations the result of mechanical irritation. McCann modified the "duodenal drainage operation" so that the duodenal secretions were emptied into the stomach instead of into the terminal ileum. Because he obtained a high incidence of jejunal ulcerations, he contends the mechanical factor is more important than the chemical one. Ferguson (27) and Ivy and Fauley (46) found that chronic ulceration of the stomach could be produced experimentally in animals by feeding rough, irritating food following excision of gastric mucosa, whereas a chronic ulcer would not develop if non-irritating foods were administered. Morton believes that trauma determines the site, whereas chemical factors determine the chronicity of ulcers.

It is well appreciated by clinicians and pathologists that superficial erosions of the gastric or duodenal mucosa can occur without producing symptoms and can be of little significance clinically. Of interest to the clinician, however, is the chronic ulcer which persists and does not readily heal as do the superficial erosions which may follow indiscretions in diet or drink. Undoubtedly, unless a number of the factors mentioned are present, the ulcer will not persist.

As the predisposing factors, "tissue susceptibility" and "ulcer diathesis," cannot be influenced by therapy, the treatment of chronic peptic ulcer must consist of the correction of those factors which are controllable, viz., hypersecretion and hyperacidity, focal infection, gastric trauma, and pylorospasm. The importance of hypersecretion and hyperacidity is becoming more appreciated by investigators and clinicians. For the past 5 years in the experimental laboratory at Tulane University, we have been conducting a series of experiments, the results of which definitely demonstrate the importance of acidity in the production of chronic peptic ulcer. Exalto, Mann and Williamson (55), and Ivy (44) have been able to produce ulcers by shunting the alkaline duodenal secretions away from the stomach by the "duodenal drainage operation." The "duodenal drainage operation" consists of division of the stomach at the pylorus, blind closure of the duodenum, division of the jejunum immediately distal to the ligament of Treitz, anastomosis of the distal portion of the jejunum to the pyloric end of the stomach and anastomosis of the proximal loop of jejunum to the terminal ileum. McCann modified the "duodenal drainage operation" so that the alkaline duodenal secretions were emptied into the fundus of the stomach instead of into the terminal ileum. Although McCann contended that mechanical trauma was more important than peptic digestion because of the high incidence of ulcers which he obtained in his experiments, Graves, in our laboratory, modifying McCann's technique so that alkaline duodenal secretions were emptied into the stomach just proximal to the gastrojejunal anastomosis (Fig. 2), demonstrated that trauma was of little or no significance, because no ulcers occurred in his animals. The mechanical arrangement in both Graves' and McCann's experiments were identical, the only difference being in acidity. Presumably because in Graves' animals the alkaline duodenal secretions emptied into the stomach immediately proximal to the gastrojejunal anastomosis, more efficient neutralization of the gastric juice leaving the stomach

was secured than in McCann's experiments. To determine the relative protective effects of bile and pancreatic juice in the stomach, Graves deviated bile and pancreatic juice, respectively, into the lower ileum without performing any other operation. In the experiments in which the bile was deviated into the lower ileum away from the duodenum, only 1 of 8 animals developed an ulcer which healed with the formation of a cicatricial stricture. In the group of animals in which the pancreatic juice was deviated away from the duodenum into the terminal ileum, no ulcers developed. The results in these experiments indicate that normally the duodenum in the dog is resistant to acid gastric chyme even though one of the alkaline secretions is deviated into the terminal ileum. There is also a suggestion that bile is possibly slightly more protective than pancreatic juice because one ulcer occurred in the group of animals with only the pancreatic juice and succus entericus to protect the duodenum, whereas no ulcers were found in the animals whose duodenums contained bile and succus entericus. In other groups of experiments Graves replaced the duodenum by a jejunal loop and attempted to determine the protective influences of bile and pancreatic juice, respectively. In one group of animals the common bile duct and in another the pancreatic duct was anastomosed to the jejunum. The animals were allowed to recover from these operations, but in none did ulcers develop. At subsequent operations the duodenum was replaced by a jejunal loop as follows: The stomach was divided immediately proximal to the pylorus and the duodenal end closed blindly. The jejunum was then divided a few centimeters proximal to the common duct or pancreatic duct transplant. The duodenal end was then anastomosed to the terminal ileum, thus deviating the succus entericus and that secretion which had not been deviated into the jejunum by the duct anastomosis. The jejunal end was then anastomosed to the pyloric end of the stomach (Fig. 3). In this way the duodenum was replaced by jejunum which was protected by only one of the alkaline duodenal secretions. In every instance, irrespective of the presence of bile or of pancreatic juice in the jejunum,

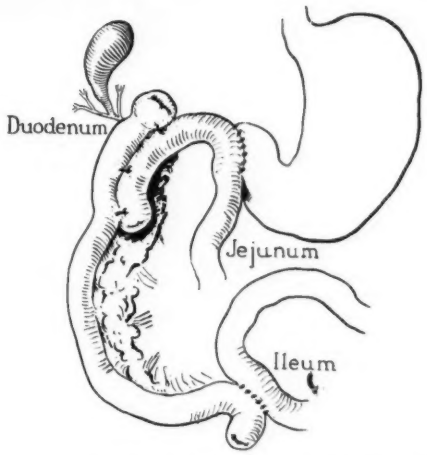

Fig. 3. Replacement of duodenum by jejunum. The pylorus has been divided, the duodenal end closed blindly. Immediately distal to the ligament of Treitz, the jejunum is divided and the duodenal end closed blindly. This is subsequently anastomosed to the ileum. The proximal end of the jejunum is closed blindly and anastomosed to the stomach. The common bile duct has been anastomosed to the jejunum so that the loop of jejunum is protected only by the bile, the pancreatic juice and the succus entericus being emptied into the terminal ileum. (After Graves. Arch. Surg., 1935, 30: 833.)

chronic ulcers developed in the jejunum immediately distal to the gastrojejunal anastomosis. The results in these experiments demonstrate that the jejunal mucosa is much more susceptible to peptic digestion of the acid gastric chyme than the duodenal or gastric mucosa and that neither bile nor pancreatic juice alone offer sufficient protection against peptic digestion. In an extensive investigation we (33, 67) demonstrated the rôle of acidity in the production of peptic ulcers. By feeding hydrochloric acid and by histamine stimulation over long periods of time, we obtained in 27 per cent of our dogs erosions and superficial gastric lesions but no chronic ulcers. In another group of experiments, pouches were formed from the lesser and greater gastric curvatures, respectively, following which the pouch was anastomosed to a jejunal loop (Fig. 4). In the animals with lesser curvature pouches and jejunal anastomoses jejunal ulcers developed in 71 per cent, whereas in those animals with greater curvature pouches and jejunal anastomoses,

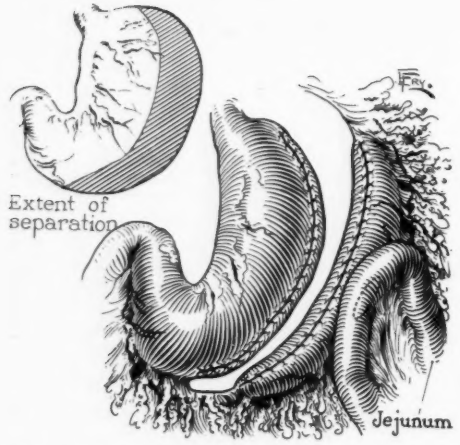

Fig. 4. Diagrammatic drawing showing formation of pouch from the greater curvature and anastomosis with the jejunum. In 100 per cent of these experiments jejunal ulcers developed, whereas in experiments with a similar pouch formed from the lesser curvature and anastomosed to the jejunum, the incidence of ulceration was 71 per cent. (After Ochsner, Gage, and Hosoi. Arch. Surg., in press.)

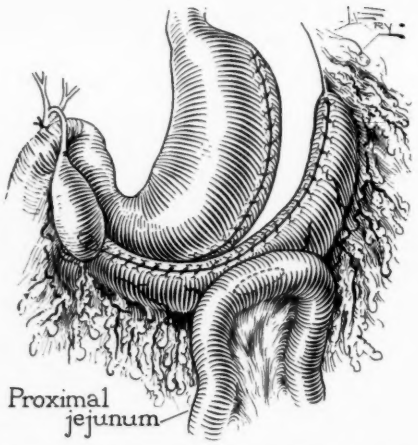

Fig. 5. Drawing illustrating formation of the greater curvature pouch with anastomosis to the jejunum and the gallbladder, deviating the alkaline bile into the gastric pouch. Following the neutralization of the gastric pouch secretion, the incidence of ulcers dropped from 100 per cent to 28 per cent. (After Ochsner, Gage, and Hosoi. Arch. Surg., in press.)

ulcers of the jejunum developed in 100 per cent. The higher incidence of ulceration in the greater curvature pouch experiments was probably due to the higher acidity in the fundic portion of the stomach which exerted a more marked digestive effect on the susceptible jejunal mucosa. In another group of experiments, the greater and lesser curvature pouches and jejunal anastomoses were repeated, but in addition the common duct was divided and the gall bladder anastomosed to the gastric pouch, thus deviating the alkaline bile into the respective gastric pouch (Fig. 5). The incidence of jejunal ulcers in the lesser curvature experiments dropped to 50 per cent, whereas in the greater curvature pouches it dropped to 28 per cent. These experiments demonstrate the protective value of alkaline bile in preventing jejunal ulcer.

Relatively recently another group of experiments has been performed by DeBakey in our laboratory in which the relative protective values of bile and pancreatic juice, respectively, were determined. As shown by von Haberer (20 per cent) and Clairmont (28 per cent) the pyloric occlusion operation, as suggested by von Eiselsberg, in a non-obstructed stomach results in a high incidence of jejunal ulcer. DeBakey performed pyloric occlusion operations in normal dogs by dividing the pylorus, closing the duodenal and gastric ends blindly, and re-establishing the gastro-intestinal continuity by means of a gastrojejunostomy (Fig. 6). In 50 per cent of the animals so treated a chronic jejunal ulcer developed immediately distal to the gastrojejunal stoma. In another group of animals the pancreatic juice was deviated from the jejunum by anastomosing the pancreatic duct to the terminal ileum. In these animals in which the jejunum was protected by the duodenal secretion and the bile, the incidence of jejunal ulceration was increased to 70 per cent. In a third group of animals, the bile was deviated from the jejunum by anastomosing the common duct to the terminal ileum. In these animals in which the jejunum was protected by the succus entericus and the pancreatic juice, the incidence of jejunal ulcers was 90 per cent. In a fourth group of animals, both the bile and pancreatic juice were deviated away from the jejunum by anastomosing the common and pancreatic ducts to the terminal ileum, thus leaving only succus enter-

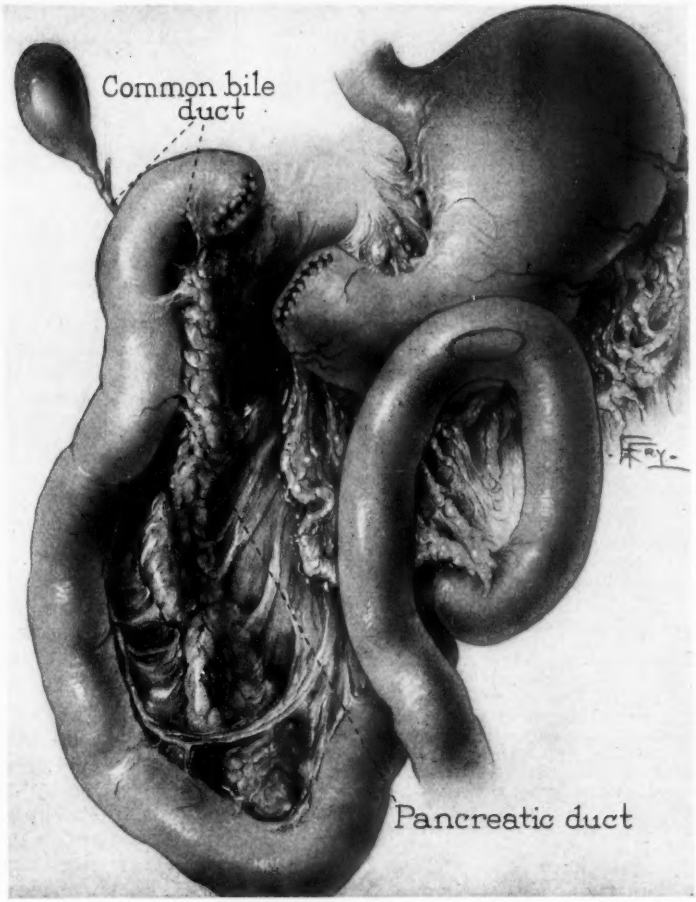

Fig. 6. Drawing showing the pyloric occlusion operation. The pylorus has been divided, the duodenal and gastric ends closed blindly, and a gastro-enterostomy produced. Following this operation jejunal ulcer developed in 50 per cent of animals. (After DeBakey. Arch. Surg., in press.)

icus to protect the jejunum. Chronic jejunal ulcers developed in 100 per cent of the animals (Fig. 7). The susceptibility of the jejunal mucosa to peptic digestion is shown by the results obtained in DeBakey's first group of experiments, as following the pyloric occlusion operation alone ulcers in the jejunum developed in 50 per cent of animals. Because the incidence of jejunal ulceration was less in those animals in which the jejunal loop contained succus entericus and bile than in those animals whose jejunum contained succus entericus and pancreatic juice (70 per cent and 90 per cent, respectively), it is apparent that bile exerts more of a protective influence against peptic digestion than pancreatic juice. The relatively greater protective influence of bile than pancreatic juice is also shown by the investigations of Berg and Jobling (9), in which following biliary fistulas peptic ulcers developed in 10 of 23 dogs, whereas no ulcers occurred after pancreatic fistulas (8). Mann and Bollman (54), on the other hand, believe that of the three secretions, viz., bile, pan-

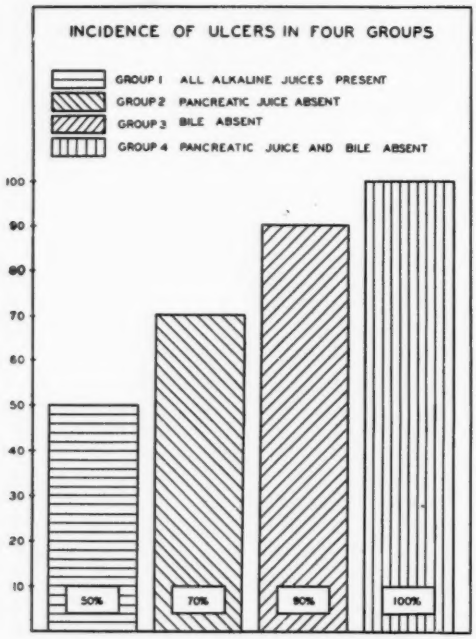

Fig. 7. Graph illustrating the incidence of ulcer obtained following the "duodenal drainage operation": Group I, 50 per cent of ulcers developed following simple "duodenal drainage operation"; Group II, 70 per cent of ulcers developed when pancreatic juice was deviated away from the anastomosis; Group III, 90 per cent of ulcers developed when the bile was deviated away from the anastomosis; Group IV, 100 per cent of ulcers developed when both bile and pancreatic juice were deviated away from the anastomosis. (After DeBakey. Arch. Surg., in press.)

creatic, and duodenal juice, bile offers the least protection. In DeBakey's last group of experiments, in which the jejunal loop contained only succus entericus, the incidence of jejunal ulceration was 100 per cent, illustrating the protective influence of both the pancreatic juice and bile.

From these experiments it is obvious that, in the experimental animal at least, which is not liable to develop peptic ulcers, two factors are of great importance in the development of chronic ulcers of the upper intestinal tract, viz., "tissue susceptibility" and acidity. Certainly in the dog there is no "constitutional predisposition" as exists in humans, because Ivy (44) found only 1 acute gastric ulcer in 900 dogs etherized in the laboratory. In the human, however, as mentioned, there are

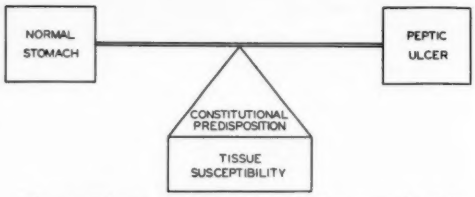

Fig. 8. Diagrammatic drawing showing normal balance maintained in a patient with tissue susceptibility and constitutional predisposition. Unless there are additional precipitating factors, constitutional predisposition and tissue susceptibility will not produce peptic ulceration.

other etiological factors which are important. In addition to "tissue susceptibility" which every one possesses, another inherent uncontrollable (as regards therapy) factor is "constitutional predisposition." In all probability, however, most patients with both of these predisposing factors will have no peptic ulceration unless there are additional precipitating factors. As graphically illustrated in Figure 8, a balance is maintained between normality and peptic ulceration. When, however, in a patient with these predisposing factors there are additional precipitating factors, such as hypersecretion and hyperacidity, foci of infection, and gastric trauma, peptic ulceration results. As graphically shown in Figure 9, the additional predisposing factors disturb the normal balance, resulting in peptic ulceration. Although hypersecretion, hyperacidity, foci of infection, and gastric trauma, either collectively or individually, are responsible for the development of peptic ulceration in a patient with a "constitutional predisposition," shown in Figure 9, they are of no significance as regards peptic ulceration in the individual with no ulcer diathesis (Fig. 10).

Based upon this conception of the cause of peptic ulcer, it is obvious that the therapy of peptic ulcer should be directed along very definite lines. Little or nothing can be accomplished as regards the treatment of uncontrollable factors, such as "constitutional predisposition" and "tissue susceptibility." As ulcer diathesis is such an important factor in the causation of peptic ulcer, probably the first requisite in the treatment of chronic gastroduodenal ulceration is that the patient be made to realize the existence of his "constitutional predisposition" to peptic ulcer and

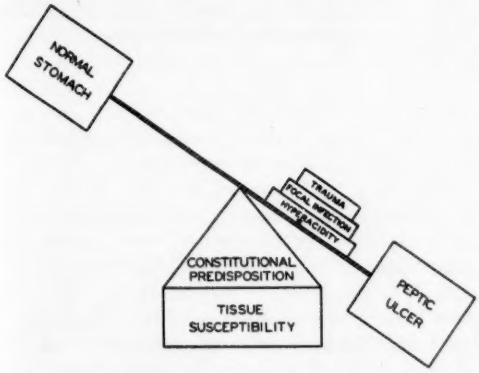

Fig. 9. Diagrammatic drawing illustrating production of peptic ulcer in a patient with the predisposing factors, tissue susceptibility, and constitutional predisposition, and, in addition, the precipitating factors, hyperacidity, focal infection, and trauma. Following the removal of the precipitating factors, the normal balance is again resumed, as shown in Figure 8, even though tissue susceptibility and constitutional predisposition persist.

the necessity of his governing himself accordingly for the rest of his life. Although one with an ulcer, potentially will always have an ulcer, a great deal can be accomplished by correcting the controllable, precipitating factors, namely: hypersecretion, hyperacidity, focal infections, and gastric trauma. Little or nothing can be done as regards the inherent "tissue susceptibility" to ulceration except that the surgeon can refrain from performing those operations in which abnormally susceptible portions of the intestinal tract are subjected to the digestive action of the acid gastric chyme. It is obvious, therefore, that in many patients with peptic ulcer the performance of a gastrojejunostomy which permits the bathing of the suceptible jejunum with acid gastric chyme can lead to disastrous results because of the development of jejunal ulcers. The reported incidence of jejunal ulceration following gastrojejunostomy for peptic ulcer in humans varies considerably. Although Lewisohn's incidence of 34 per cent is probably abnormally high, we are convinced from our clinical experience that the incidence is considerably higher (probably 15 to 20 per cent) than is generally considered by most clinicians. Hinton and Church, who report a jejunal ulcer incidence of 16.4 per cent, emphasize

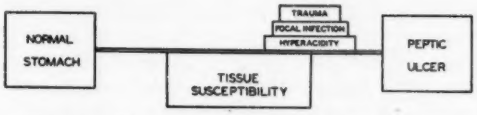

Fig. 10. Diagrammatic drawing showing the normal balance maintained even though the precipitating factors, hyperacidity, trauma, or focal infection, are present in an individual without constitutional predisposition. Even though the precipitating factors are present, the patient does not develop an ulcer.

the necessity of observing patients with gastro-enterostomy for long periods of time, because not infrequently long periods elapse between the performance of the operation and the appearance of the jejunal ulcer. Balfour found an incidence of jejunal ulceration of 3.26 per cent in duodenal ulcer cases treated by gastro-enterostomy, but found none in those in which this operation was performed for gastric ulcer. Walton found the incidences of jejunal ulcer following gastrojejunostomy for gastric and duodenal ulcers to be 2.2 per cent and 3.9 per cent, respectively. Ryle and Zukschwerdt and Eck believe that 10 per cent of gastrojejunostomies are followed by jejunal ulcers. The great frequency of jejunal ulcer is demonstrated by Graham and Lewis' report of 43 cases which they observed, upon 33 of which they themselves had operated.

The therapy of gastroduodenal ulceration has not been satisfactory mainly because of the high incidence of recurrences which have taken place largely because the treatment has consisted of attempts to heal the ulcer without correcting the predisposing and precipitating factors. In the successful therapy of peptic ulcer the patient as a whole must be treated and not merely the gastroduodenal ulceration, which is only a symptom. Although, as mentioned previously, the predisposing or underlying factors are largely uncontrollable, that is, are not amenable to therapy, a great deal can be accomplished by rest and relief from worry. The importance of fatigue and worry as causes of peptic ulcer are shown by Barford's observations. In 126 cases of duodenal ulcer studied by him, the most frequent cause of aggravation of symptoms was worry (26 cases), whereas the second most frequent causes were overwork and fatigue (14 cases). Psychic and physical rest are important in the

treatment of patients with recurrent peptic ulcer and always should be insisted upon. As little can be done, however, to correct the predisposing factors ("constitutional predisposition" and "tissue susceptibility"), the treatment of peptic ulcer consists mainly of the correction of the precipitating factors which are amenable to therapy. These controllable factors, as heretofore mentioned, are hypersecretion and hyperacidity, focal infection, gastric trauma, and pylorospasm. Of the various controllable factors, undoubtedly the most important are hypersecretion and hyperacidity. The importance of acidity in the causation of peptic ulcer is shown by our experiments as regards the formation of ulcers both in the stomach and in the intestinal tract. As a matter of fact, the treatment of peptic ulcer in the past has consisted largely of measures which decrease or control gastric acidity, whether this is accomplished by nonoperative or operative means. Because of the etiological importance of gastric acidity, it is imperative that the patient abstain from those things which increase the acidity. The abstinence must be persisted in throughout the patient's life, because one with an ulcer diathesis has an inherent predisposition to ulceration as long as he lives. We feel that it is imperative that the patient completely abstain from smoking because in our experience, smoking, especially of cigarettes, is very detrimental to patients with peptic ulcer. Gray (36) found that in a series of duodenal ulcer cases, 96 per cent were smokers, of which 29 per cent were excessive, 31 per cent heavy or continuous, and 40 per cent mild or intermittent smokers. This authority believes that tobacco is one of the principal causes of peptic ulcer. Moll and Flint found that smoking increases the secretion of hydrochloric acid in the stomach and tends to produce a hyperchlorhydria. Bandel and Friedrich suggest that the increase in the gastric ulcer incidence in Germany has been due to the concomitant increase in cigarette smoking. Friedrich believes that cigarettes are especially harmful, because most cigarette smokers inhale, thus increasing the absorptive surface eight times, resulting in approximately eight times as much absorption of nicotine. Also the cigarette smoker is likely to smoke between meals when the stomach is empty, at which time hyperacidity is especially dangerous. Friedrich believes that the absorbed nicotine exerts a twofold action: first, it produces spasm of the blood vessels of the stomach, as he was able to determine by capillary microscopy, and, second, it increases gastric secretion. The former is due to the direct action of the nicotine on the vessels or due to the increase in adrenalin resulting from the action of the nicotine on the adrenal glands. The vasospasm produces an ischemia of the gastroduodenal mucosa which results in necrosis. Seventy-nine and seven-tenths per cent of Friedrich's male patients with ulcer were heavy smokers. The importance of smoking after operation is shown by Friedrich's results. Of 34 resections in patients who smoked heavily after operation, although they had been instructed not to do so, practically half the patients had symptoms. Of 44 patients who smoked heavily before operation, but who limited their smoking to half the amount or even less after operation, only 6 had moderate symptoms, one-seventh of the entire group. Smoking was particularly injurious to those patients with gastro-enterostomies. Of 14 patients with gastro-enterostomy who had not limited their smoking after operation, only 4 were free from symptoms, whereas of 30 patients who smoked moderately following the operation, 26 were completely free from symptoms. According to Friedrich and I. Gray there is less danger if smoking is limited to the immediate period after a meal, because during this phase food neutralization will tend to prevent hyperacidity. Friedrich states that almost invariably those patients who do not get results following an operation are those who smoke in the morning before breakfast. He compares the effects of nicotine on gastric acidity with that which is obtained in animals by sham feeding. We are so convinced that smoking, and especially cigarette smoking, is detrimental to the patient with peptic ulcer that we refuse to treat such an individual unless he will totally abstain from smoking. Trowell studied the smoking habits of 50 duodenal ulcer male patients and 400 normal men and found 17 per cent non-smokers in

the normal group and only 8 per cent in the ulcer patients. Fifty-two per cent of the controls and 78 per cent of the ulcer patients inhaled the cigarette smoke, whereas 44 per cent of the controls and 18 per cent of the ulcer patients did not inhale. Trowell believes that the inhalation of cigarette smoke is an important factor in the etiology of duodenal ulcers and suggests that the detrimental agent absorbed is carbon monoxide. Rolleston believes that smoking causes pylorospasm which in turn may cause hyperchlorhydria. On the other hand, according to Barnett smoking is of little etiological importance in peptic ulcer and gastric neurosis.

Similarly as with smoking, all patients with peptic ulcer should be strictly forbidden to imbibe any alcoholic beverages because of the definite irritation of the stomach which is produced by them and because of the hypersecretion which results from their ingestion. According to Cushny, following the absorption of alcohol into the blood stream there is profuse gastric secretion. Because alcohol provokes such marked gastric secretion dilute solutions are frequently used as test meals. Although of less importance than smoking and drinking as regards the production of gastric hypersecretion and hyperacidity, condiments of all types should be avoided by the peptic ulcer patient. Condiments are detrimental probably in two ways: by increasing the gastric secretion and acidity and by producing gastritis and duodenitis.

In addition to preventing increased gastric secretion by avoiding those factors which produce hypersecretion and hyperacidity, neutralization of gastric acidity is of great therapeutic importance. Normally, neutralization occurs in a number of ways, but principally by the ingested food and by regurgitation of the alkaline duodenal secretions. Frequent administrations of food are essential in the efficient neutralization of the gastric juice and most of the medical therapies of ulcer consist principally of frequent feedings. Hurst (43) believes that the neutralizing effect of food is dependent upon its alkalinity. Mann and Bollman state that there is "a peculiar quantitative relationship between food and gastric acidity." They have found that "the high acidity of the gastric juice in a dog with psychic secretion was reduced for only 2 or 3 minutes following administration of 20 cubic centimeters of milk or cream; 40 cubic centimeters maintained a reduced acidity for 5 or 10 minutes, but 80 cubic centimeters maintained a low level of acidity for almost 2 hours." Winkelstein (82) found that nocturnal gastric secretion occurs in patients with peptic ulcer, but never in normal individuals (84). He (83) found that the nocturnal gastric hypersecretion can be effectively controlled by the continuous administration (night and day) of food and alkalies through an indwelling gastric catheter. On the basis of his experimental observations that following the extirpation of portions of the gastric mucosa ulcers developed only when salivary glands were also removed, Demel believes that the saliva normally exerts a protective influence against gastroduodenal ulcer. We believe that the frequent administration of food, at least every 2 hours until the patient retires at night, is extremely important. Although during the time the ulcer is healing the diet prescribed must be more rigid, it is imperative to impress upon the patient that his eating habits must be changed for the rest of his life. If such is the case, it is essential that the diet is liberal enough for the patient to be content with it for such a long period of time. We believe that if condiments, roughage, and excessive meat consumption are avoided, almost everything else can be taken safely, provided there are frequent feedings and no overfilling of the stomach at any time. *Although we admit the value of the rigid diets suggested by gastro-enterologists during the stage of ulcer activity, we are convinced that much harm can result from the overemphasis of the importance of the relatively short dietary regimen and the frequent disregard for continued dietary discretion.* Of great importance also is avoidance of overdistention of the stomach at any time. The patient should be instructed to eat frequently, at least every 2 hours, but to eat sparingly at his three regular meals.

Although the conservative treatment of peptic ulcer by many internists and gastroenterologists has consisted largely of attempted neutralization of the acid gastric secretion

by the use of alkalies, we believe with Barford that alkalies are of relatively little significance, although if used properly may be of some value. In Barford's series of 160 cases of chronic ulcer, the conservative treatment consisted of ulcer diet together with the administration of atropine but without alkalies. During the acute stage of the ulcer and until the ulcer has healed, we employ alkalies after meals but feel that the usually employed alkali, sodium bicarbonate, should not be used because, as shown by Lockwood and Chamberlain, frequently following the administration of sodium bicarbonate there is a rebound hyperacidity to a point higher than that which was present before the alkali administration. Also as shown by Loevenhart and Crandall, sodium bicarbonate is irritating in high concentrations and is likely to produce alkalosis if taken in excess. These investigators also state that occasionally it causes a precipitation of phosphates in crystal form in the urine, which may give rise to renal colic. Mann and Bollman have also emphasized the limitation of alkali therapy with sodium bicarbonate because of the only temporary decrease in acidity produced by small doses of the sodium bicarbonate and the danger of producing an alkalosis if large doses are used. In our clinical cases we have used calcium carbonate, as suggested by Loevenhart and Crandall and have been very well satisfied with the results which we have obtained. According to Loevenhart and Crandall, the advantages of calcium carbonate are as follows: "(1) When suspended in water, it is neutral in reaction. (2) It is therefore only a potential alkali, but it neutralizes the gastric acid to form calcium chloride and carbon dioxide. (3) It can be given almost *ad libitum*. If an excess is taken, it passes out in the feces. (4) It apparently has no effect on the activity of the bowel except that, if taken in excess, it increases the bulk of the stool. (5) When taken in excess, it will coat over ulcerated areas and may in this manner protect them from the action of irritants." Loevenhart and Crandall found that, in a normal individual, 1 gram of calcium carbonate would neutralize the average basal secretion for 7 hours or would neutralize the maximum basal secretion for 1 hour and 40 minutes. We have used calcium carbonate, 10 to 20 grains, after each of the three regular meals and in this way have been able to control satisfactorily the acidity in patients with ulcer. A decided disadvantage of the magnesium salts, magnesium oxide and carbonate, is that they exert an irritating action on the intestine which, as Loevenhart and Crandall emphasized, is especially undesirable in ulcer patients who frequently have an irritable colon.

The neutralization of gastric secretion by means of mucin, as suggested by Fogelson (30), is of value in many cases of peptic ulcer. According to a recent report by Fogelson (31), 63.1 per cent of patients who were considered as having intractable ulcer symptoms became symptom free on mucin therapy. Of the remaining patients, 29.4 per cent were benefited by the treatment and 7.5 per cent were not benefited. According to Hurst (43) mucus acts partly by mechanically blocking the mouths of the secreting tubules and partly by its chemical action combining with some of the free acid. He believes that the neutralizing effect is almost entirely due to the sodium bicarbonate it contains. He has shown that in a patient with a hypersthenic stomach, which is the type usually associated with duodenal ulcer, very little mucus is present in the stomach.

As mentioned, one of the causes of hypersecretion and hyperacidity is gastric retention, which is caused by an interference with the normal emptying of the stomach. The increased secretion and acidity are partly due to the retention of the normal gastric juice in the stomach, and, as Meek suggested, because of the retention, there is an increased secretion. Also the normal regurgitation of the alkaline duodenal secretion is interfered with. The interference with the emptying of the stomach and the normal regurgitation of the alkaline duodenal secretion may be due either to a spasm of the pyloric sphincter (pylorospasm), as contended by Ivy and Fauley (46), Finney (29), Judd and Waldron, and Yates, or the absence of normal relaxation (achalasia), as suggested by Hurst (43), Miller (61), Martin and Burden, and Deaver and Burden. As there is interference with the

normal relaxation of the pyloric sphincter in cases of ulcer, attempts should be made to re-establish the normal function of the pylorus. This is best accomplished by the administration of antispasmodics given in full therapeutic doses. Tincture of belladonna given in doses varying from 10 to 20 minims three times a day after meals is usually successful in relaxing the pyloric sphincter. By so doing the vicious circle which is set up by gastric retention and prevention of regurgitation of the normal alkaline duodenal secretions together with increased secretion resulting from the gastric retention is corrected. In cases in which there is considerable retention and especially in those cases in which there is an acute inflammatory process, the gastric retention must be relieved in some other way, and this is best accomplished by gastric lavage, especially late in the evening. An inflammatory reaction about an ulcer will subside very much earlier if stasis over long periods of time with putrefaction in the stomach can thus be prevented. Conservatism, of course, is indicated only in those instances in which the mechanical obstruction is due to edema and not due to cicatricial narrowing, because in the former instance the process may subside completely, whereas in the latter the conservative treatment offers nothing.

In addition to hyperacidity, another important precipitating cause of peptic ulceration which must be corrected is focal infection. As mentioned, focal infections may act in a specific manner by producing a specific lesion in the stomach or the duodenum, the ulcer following the gastritis or duodenitis. Such foci of infection are usually in the teeth and tonsils, but may be elsewhere in the body. The removal of these foci will, in many instances, bring about complete relief of symptoms in an otherwise intractable case. In addition to the specific focal infections, as mentioned, there are non-specific focal infections which are usually located within the abdomen and which reflexly produce pylorospasm which in turn increases gastric acidity. Unless these foci are removed and the reflex spasm of the pylorus prevented, relatively little can be accomplished as regards an ultimate cure of the individual. The possibility of an inflammatory lesion in the abdomen which may be responsible for a reflex pylorospasm must always be considered and when found the viscus should be extirpated.

In order to minimize gastric trauma, which is another but less important precipitating cause, the patient with peptic ulcer should avoid all rough food, such as uncooked vegetables or fruit. The importance of trauma from the ingestion of roughage is illustrated by the researches of Ferguson, and of Ivy and Fauley (46). These investigators found that following excision of gastric mucosa a chronic ulcer would develop if the animals were fed rough, irritating food, whereas the ulcer would heal if non-irritating foods were administered.

Because of the necessity of treating the patient as a whole in cases of peptic ulcer, the conservative treatment should be used in every case unless there is some complication which requires surgical aid. The surgical treatment of gastroduodenal ulceration, therefore, consists largely of the treatment of complications. Obviously a patient with mechanical obstruction, with threatened or actual perforation, with repeated hemorrhages or one in whom the possibility of a malignant lesion cannot be excluded, must be operated upon, but each of these conditions represents a complication of the original ulcer. Occasionally, but infrequently, an operative procedure may be indicated in an attempt to control the hyperacidity in the patient who is not benefited by conservative treatment. Unfortunately, however, the patient who does not respond to a properly conducted regimen of conservative therapy is likely not to respond to operative therapy, as borne out by Emery's observations. He reported 4 cases of hypersecretion which were treated by increasingly radical operations. Each patient had a high gastric acidity and each patient was worse after the operation than before. As a rule, unless there is some definite complication which is an indication for surgical therapy, the patient is probably better off without being operated upon. Another fact also remains that every patient operated upon is still a peptic ulcer patient and should continue on the same regimen after operation as he did before operation.

The surgical treatment of peptic ulcer consists largely of the correction of the complicating lesion. We feel that every patient who has a chronic calloused gastric ulcer should be given the advantage of an exploration and probable resection, because of the great danger of malignant change occurring in this type of ulcer, especially if the ulcer is on the greater curvature. Even though the lesion does not appear to be malignant, a subtotal gastrectomy should be done well beyond the confines of the ulcer because it is impossible to tell at the time of operation whether it is malignant or not. Another surgical procedure which is definitely indicated and about which there can be no controversy is gastro-enterostomy in the patient who has had a long standing cicatrizing ulcer in the region of the pylorus associated with gastric retention and hypoacidity. The results obtained from this operation in these cases are excellent. The danger of the development of jejunal ulceration in these cases is practically nil because, as the result of the continued gastritis caused by prolonged gastric retention, the acid secretion of the stomach is definitely diminished, thus obviating peptic digestion of the susceptible jejunal mucosa. The operative procedures which should be done in other cases, those with threatened or actual perforation, hemorrhage, or those which do not respond to conservative therapy are not so definite. In perforated peptic ulcers conservative operative procedures are generally indicated. These consist of excision of the ulcer and immediate closure without the performance of a gastrojejunostomy. In cases with hemorrhage we feel whenever possible operation should not be undertaken until after the hemorrhage has subsided and the patient has recovered. In such a case following recovery from the effects of the hemorrhage, extirpation of the ulcer combined with some plastic operation on the pylorus or gastrectomy is usually indicated because a severe hemorrhage generally indicates that the ulcer is a penetrating one which will probably not subside spontaneously under conservative therapy. Occasionally the severe hemorrhage does not subside and even threatens the patient's life. In such an instance partial gastrectomy with removal of the ulcer, as advocated by Allen and Benedict, is indicated.

Because of the important rôle which acidity plays in the production of peptic ulcer, as evidenced by clinical and experimental observations, and because of the increased susceptibility of the intestinal mucosa to the acid gastric secretion, we are convinced that a gastrojejunostomy should seldom, if ever, be done in the patient who has a normal or hyperacidity of the gastric secretion. In an individual with ulcer diathesis, gastric hypersecretion, and hyperacidity, the performance of a gastrojejunostomy is not without danger because it permits the acid gastric chyme to be emptied into the jejunum, which is less resistant to the digestive action of the gastric juice than the gastric or duodenal mucosa. The high incidence of jejunal ulcers in such individuals is easily explained. As a matter of fact, it is difficult to understand why such a patient with a gastrojejunostomy should ever escape a jejunal ulcer. The reason more do not develop stomachal or jejunal ulcers is probably because a properly performed gastrojejunostomy does reduce the gastric acidity, although, as shown by the investigations of Hill and associates, the reduction is less than that obtained by gastroduodenostomy. Granted that partial neutralization of the acid gastric contents follows gastrojejunostomy, the operation still remains a dangerous procedure, because of the marked susceptibility of the jejunal mucosa unless complete neutralization of the gastric chyme is obtained. As the result of our clinical and experimental observations, we believe that careful gastric analyses are important before any surgical procedure on the stomach is undertaken and we are convinced that in the presence of a hyperacidity or even a normal acidity a gastrojejunostomy should not be done. Because the patient is not only not cured of his ulcer disease by the gastro-enterostomy, but also because a jejunal ulcer is infinitely worse than the original gastric or duodenal ulcer, any procedure which might be responsible for the development of a jejunal ulcer should be avoided.

A far more logical procedure than the establishment of a new opening between the stom-

ach and the jejunum is some type of operation in the region of the pylorus which will permit a freer regurgitation of the alkaline duodenal secretions into the stomach and thus produce a reduction in acidity. The importance of regurgitation of alkaline secretion as neutralizing factors has been shown by the investigations of Boldyreff, Elman and Eckert, Olch, Bockus and associates, and Hill and associates. The advantage of such an operation is that it tends to correct a disturbance which exists in patients with peptic ulcer, viz., a dysfunction of the pylorus, and it also retains the physiological relationship of the stomach and the duodenum, so that the acid gastric chyme leaving the stomach first comes in contact with the duodenal mucosa which normally should receive it and which is much more resistant to its digestive action than is the jejunal mucosa. Granted that the pyloric dysfunction is either a loss of relaxation or spasm of the muscle, theoretically the most physiological procedure would be excision of the pyloric sphincter, as suggested by Judd (47, 48) and Deaver and Burden. The operation consists of excision of a portion of the pyloric sphincter, which will permit emptying of the stomach without retention and also a ready regurgitation of the alkaline duodenal secretion into the stomach in order that neutralization may occur. In a recent publication, Judd and Waldron (49), emphasized the importance of excision of from two-thirds to three-fourths of the pyloric sphincter because if less of the muscle is removed than this, recurrence of the symptoms occur. They state that the operation has been done at the Mayo Clinic in more than 900 instances and that the only patients in whom there has been a recurrence of symptoms are those in whom adhesions formed between the operative field and the parietal peritoneum or adjacent viscera. In these cases recurrence of the pyloric occlusion was not caused by the reformation of the sphincter, but was due to angulation produced by the adhesions. The operation is, without a doubt, the most physiological of all the gastric operations, because it disturbs the normal anatomy and physiology of the stomach and duodenum less than does any other procedure. If excision of the pyloric sphincter is not feasible for technical reasons, an anastomosis between the stomach and duodenum (gastroduodenostomy) with—Heinecke-Mikulicz, 60; Finney, 28; Horsley; and Judd, 49—or without (Rienhoff and Wilkie) division of the pyloric ring is then advisable, because in this way the emptying of the stomach into the duodenum, which is accustomed to receiving the acid gastric chyme, can be accomplished and at the same time regurgitation of the alkaline duodenal secretion into the stomach can occur. Local excision of the pyloric or juxtapyloric ulcers always should be done during the plastic operation, whenever it is at all possible. Occasionally, patients with peptic ulcer in whom excision of the pyloric ring, gastroduodenostomy, or other plastic operation on the pyloric sphincter is not possible but in whom there is a hyperacidity and in whom for some reason or another operation is indicated, a subtotal gastrectomy can be done. It is an operation which entails a great deal more risk than gastro-enterostomy but the incidence of jejunal ulcer is considerably less because the acid producing portion of the stomach is diminished. We believe, however, that unless the ulcer is in the stomach and there is some chance of its becoming malignant, gastric resection is seldom indicated. We do not agree with Strauss, Berg (8), and the various European clinicians that gastrectomy is the operative procedure of choice, because the removal of the greater portion of the stomach does not necessarily correct the disturbed physiology which is responsible for the ulceration.

CONCLUSIONS

1. The treatment of peptic ulceration has been very unsatisfactory because, in too many instances, attention has been focused on the ulcer itself without the realization that the ulcer is merely a symptom. Unless the patient as a whole is treated, the results from therapy are likely to be unsatisfactory.

2. The causes for peptic ulcer can be divided into two groups: one in which the factors are not amenable to therapy but which are inherent and predisposing, and the others which are precipitating but which are controllable, i.e., can be corrected. The inherent or predispos-

ing factors are: (1) tissue susceptibility and (2) constitutional predisposition. The precipitating factors are: (1) hypersecretion, (2) hyperacidity, (3) focal infection, and (4) gastric trauma.

3. Tissue susceptibility, which is an inherent quality present in all individuals, is the vulnerability of certain portions of the gastrointestinal tract to peptic digestion, such as the lesser curvature (*Magenstrasse*), pylorus, duodenal cap, jejunum, and other portions of the intestinal tract subjected to the acid gastric chyme, as Meckel's diverticulum containing islands of gastric mucosa.

Constitutional predisposition, although difficult to define, is unquestionably present in most if not all patients with chronic gastroduodenal ulceration.

4. As the predisposing factors are not controllable, i.e., are not amenable to therapy, the treatment of a patient with peptic ulcer consists of the prevention and the correction of the precipitating factors, hypersecretion, hyperacidity, focal infections, and gastric trauma. Hypersecretion and hyperacidity are the most important precipitating factors. The peptic ulcer patient must abstain from those activities which increase gastric secretion and acidity—smoking, especially of cigarettes, ingestion of alcohol and condiments.

In addition to the abstinence of those activities which provoke hypersecretion and hyperacidity, neutralization of gastric acidity is favored by a diet consisting of frequent small feedings, as food is an important neutralizing agent. Alkalies are probably of less value than formerly considered. Sodium bicarbonate is not an efficient neutralizing agent because frequently there is a rebound hyperacidity even greater than that before the administration of the alkali. There is also danger of alkalosis from the use of excessive amounts. The alkali of choice is calcium carbonate. Mucin administration is of value in controlling hyperacidity in many cases. Restoration of the normal function of the pyloric sphincter—relief of pyloric spasm or achalasia by means of antispasmodics—is of importance in the therapy of peptic ulcer, because it relieves gastric retention and also diminishes secretion, which is stimulated by gastric retention. The relaxation of the pyloric sphincter permits free regurgitation of the alkaline duodenal secretion into the stomach and favors neutralization.

5. All foci of infection must be removed, because they can act either directly by producing a specific inflammation in the stomach or duodenum, or reflexly when within the abdomen by producing pylorospasm.

6. In order to minimize gastric trauma, only bland foods containing no roughage should be allowed.

7. Because of the constitutional predisposition to ulceration, it is imperative that the patient change his mode of living for the rest of his life, for recurrences can be expected unless the precipitating factors such as hypersecretion, hyperacidity, focal infection, gastric trauma, are prevented throughout the life of the patient.

8. The surgical treatment of peptic ulcer consists largely of the treatment of complications, such as mechanical obstruction, perforation, repeated hemorrhages, and danger of malignant change. Only rarely is a surgical operation indicated in those cases which do not respond to conservative therapy.

9. In a case of pyloric occlusion with prolonged gastric retention and hypo-acidity, gastro-enterostomy is the procedure of choice. However, in cases with hyperacidity or normal acidity, because of the increased susceptibility of the jejunal mucosa to the acid gastric chyme, gastrojejunostomy should seldom, if ever, be done because of the danger of the development of a gastrojejunal ulcer. In such cases the resection of the pyloric sphincter or the performance of a gastroduodenostomy which permits free regurgitation of the alkaline duodenal secretions into the stomach thus favoring neutralization of the acid gastric contents and at the same time not changing the normal gastroduodenal relationship, is to be preferred to gastrojejunostomy. The duodenal mucosa is more resistant to the acid gastric chyme than is the jejunal mucosa. The chronic calloused ulcer in the stomach which does not respond readily to therapy should be operated upon and radical resection done, because of the danger of malignant change.

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Discussion

EMILE HOLMAN, M.D., San Francisco: Dr. Ochsner's comprehensive paper illustrates the inevitable overlapping of the boundaries of medicine and surgery in any consideration of peptic ulcer. As Shelton Horsley once said: "There must be medical treatment in all cases and there must be surgical treatment in some." Since Boldyreff's original assertion that peptic ulcer is due to a breakdown of the regulation of gastric acidity, overwhelming experimental evidence has been obtained in support of his theory that autodigestion due to increased acidity is one of the most important factors in the development of gastric and duodenal ulcer. In this experimental work Dr. Ochsner has taken a leading part, and many fundamental facts have been developed in the laboratory by him and his associates.

An important factor in the breakdown of the acidity regulation is an altered motility of the stomach characterized most conspicuously by a spasm of the pyloric sphincter. The etiology of such a spasm remains obscure but once present it perpetuates a vicious circle which inevitably leads to chronic disorder. Hughson's experimental observations suggest that the initial instigator of the pyloric spasm may be an inflammation of the peritoneum. He observed pylorospasm and a marked delay in the emptying time of the stomach following a localized peritonitis anywhere in the abdomen. Clinically, such an inflammation may have its seat in a diverticulitis, an appendicitis, a cholecystitis, or even a salpingitis. You are all familiar with the long existing clinical presumption of a relationship between these conditions and duodenal ulcer. Such peritoneal irritation does not, however, account for all cases of pylorospasm, and we are forced into acknowledging a nervous origin of the spasm, initiated, according to Cushing, by central stimuli; or perhaps having its inception in a hyperactive sympathetic system acutely attuned to an environment productive of mental strain, mental irritation, and mental fatigue. It is highly probable that such a pylorospasm is the first factor in the vicious circle of pylorospasm—decreased gastric motility—gastric stasis—hyperacidity—ulceration, rather than the sequence of hyperacidity—pylorospasm and ulceration as suggested by certain authors.

Granting that pylorospasm may be an important factor in the development of hyperacidity and ulceration, the only truly physiological operation, following failure of systematic medical care, would be complete excision of the pylorus by the so-called Billroth I operation or a modification of it. The Finney, Judd, and Horsley pyloroplasties aim to eliminate the pyloric sphincter by partial excision, but experience indicates that such partial excision is occasionally ineffective, and not always applicable, and we believe complete excision of the pylorus to be more physiological and therefore more effective. Such a procedure obviates the inherent objection to any form of gastrojejunal anastomosis, namely the flow of unmodified gastric juice directly over the jejunal mucosa, and it also provides for the easy reflux of biliary, pancreatic and duodenal alkaline secretions into the stomach, which Boldyreff considered so essential to the normal acidity regulation of the gastric secretion. We believe the division of circular fibers of the duodenum and stomach, which in the Finney, Judd, and Horsley pyloroplasties is inevitable, leads to local visceral paralysis and stasis and may interfere with this unhindered reflux of duodenal contents into the stomach.

The operation of simple gastrojejunostomy in the presence of hyperacidity cannot be condemned too strongly and should be employed only in the presence of a proven anacidity or hypo-acidity.

Certain mechanical considerations are of major importance when a gastro-enterostomy is contemplated. The disturbed motility of the stomach or duodenum in the presence of an ulcer may produce not only a pylorospasm, but may produce also a spasm of the gastric or duodenal musculature opposite the ulcer. When these spasms occur simultaneously, there results a distention of the visceral segment between the ulcer and the pylorus, and it is suggested that this distention is responsible for much of the epigastric discomfort of peptic ulcer. Any operation which fails to prevent such distention of the segment lying between the ulcer and the pylorus may well fail to correct the epigastric discomfort incident to the ulcer.

Dr. Ochsner suggests that in the diet one omit roughage and uncooked fruit and vegetables. Patients invariably object to such a diet because it promotes constipation and because of its monotony. Their hunger for something fresh is very real and sometimes overpowering. It would seem that it is a question not so much of adhering to a diet without roughage as it is a matter of eliminating from the diet some chemical element capable of exciting gastric secretion and of provoking such discomforts as heaviness, epigastric gnawing, and regurgitation. Cantaloupes, watermelons, fresh pineapples, apples and berries excite these difficulties. On the other hand, scraped banana, fresh prunes, persimmons, peaches, and ripe blackberries are usually well tolerated. Similarly, lettuce, tender celery, and fresh carrots unadorned by spices and sauces usually produce little discomfort, and are a source of vitamins so necessary for normal well-being.

It is a pleasure to be able to endorse heartily Dr. Ochsner's admirable paper.

FUNDAMENTALS VERSUS GADGETS IN THE TREATMENT OF FRACTURES[1]

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THERE is a passage in the Bible which in part reads: "This is an evil generation. They seek a sign: and there shall no sign be given. . . ." In the fear that the statements made herein may lead some to think that I am of the opinion that this is an evil generation of surgeons, I hasten to state that this is quite contrary to the fact. Progress is achieved through the ideas and work of many men. It is necessary, however, to sift these ideas and take the good out of any or all and throw aside whatever is not adaptable to our purpose. A sign, a cure, a panacea, which will bring good results for our patients has not yet been given.

Each person is an individual and differs from all others, consequently each case must be considered a law unto itself. Fractures do not differ from other conditions in this. Although fractures are mechanical and tangible things, an apparatus will not do in one case what it has done in another. A new method of treatment is not necessarily good; it may have worked wonders in one case and in the hands of its originator, but may be a total loss in another similar case. In these days of mechanical advancement, we see many devices of strange and wonderful design advocated for the reduction and retention of fractures. Some are very ingenious applications of standard appliances to meet a condition which has arisen in a given case, some are strange and mechanical contrivances which it would take a Philadelphia lawyer and a mechanical engineer to apply. They might work if one could apply them, with nothing to bother about but mechanics, but many devices do not take into account the anatomy and physiology of the parts to be treated, and consequently cannot be used successfully in any but the unusual case. Such apparatus confuses and in the maze of mechanical gadgets the *principles* of treatment of the individual fracture in hand are overlooked and forgotten. There can be no objection to devising an apparatus which serves to answer a need in any case, but to the average surgeon it would be much more useful if it were presented as the application of a principle.

Fractures are not new in the field of surgery. Records of fracture treatment are in existence which were written 4500 years ago. The Edwin Smith surgical papyrus, of which the late Dr. James R. Breasted, professor of Egyptology at the University of Chicago, recently made an admirable translation, is apparently a collection of case histories extending over several centuries, and dating back to the 5th Dynasty. The distinguished gentlemen who delve into Egypt's past dispute among themselves the approximate date of the different dynasties, but are in apparent agreement that the 5th Dynasty reigned in Egypt at least 4500 years ago. Dr. Breasted and Dr. G. Elliot Smith, professor of anatomy in the Egyptian Government School of Medicine, have made some interesting observations on mummies exhumed in recent years. Breasted says that between 5000 and 6000 bodies were examined and that one in every 22 showed a fractured bone. Splints have been found still in place, but Breasted says that such cases must have succumbed soon after injury as no evidences of healing are seen. Fracture of both bones of the forearm was frequent, due to the custom in Egypt, then as today, of fencing with heavy sticks. These fractures were treated logically and the results, according to Smith, were excellent. The bark of a tree, supposedly the acacia, was molded carefully around the fractured arm from the base of the fingers to the elbow, and was well padded around bony points with folded linen. In 100 cases studied, many of which must have been compound, only one showed signs of suppuration.

Fractures of the femur did not fare so well. Splints were applied which immobilized the lower fragment including the knee and ankle, but extended only a few inches above the level

[1] Fracture oration presented before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935

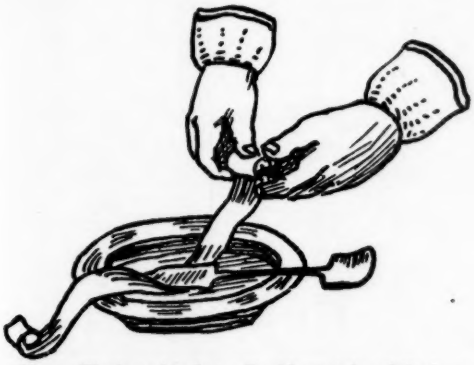

Fig. 1. Waxing a bandage. Double spatulas of the form shown are found among ancient Roman instruments from Pompeii. (After Scultetus.)

of the fracture. The results, as might be expected, were poor, and many show considerable shortening, displacement of bones, and exuberant callus. Not infrequently a case is brought into the accident ward today splinted with as little thought and understanding in exactly the same way, and we are inclined to wonder whether, after all, we have progressed far since the days of the Pharaohs.

Our next historical evidence of the treatment of fractures dates to the time of Hippocrates, the Father of Surgery as well as of Medicine. In his three books wherein fractures and dislocations are considered, the fundamental principles in the treatment of fractures which he describes might find a place in the most modern textbook. These differ little from the generally accepted methods of today except from the standpoint of open reduction. The keynote of treatment 2500 years ago, as now, was traction and countertraction; so far as we know the Greeks did not apply suspension with continuous traction and countertraction, but they very apparently did take into consideration the constant displacing effect of muscles. The equivalent of our plaster cast was made by passing strips of thin cloth through melted wax, which hardened; the bandage was bound around the fractured limb while traction and countertraction was maintained (Figs. 1 and 2). These casts were reinforced with splints applied outside the cast and bound to it (Fig. 3). Traction and countertraction was

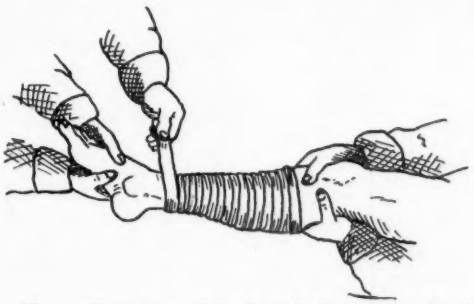

Fig. 2. Second waxed bandage fixed over the site of fracture and carried downward for several turns, preparing to return upward and end at the top of the first bandage. (After Scultetus.)

maintained by well padded wooden cuffs cut to fit at suitable points above and below the fracture; the cuffs were then held apart by rods of wood which acted as a straight spring. Hippocrates says that these bands must be well padded at bony points "as tissue dies beneath a constantly maintained pressure." He emphasizes this time after time (Figs. 4 and 5).

Apparently the reduction of fractures and dislocations was well understood, and many ingenious and powerful appliances are described for the use of the surgeon. The glossiconium for the reduction of fracture of the femur used pulleys and a windlass to exert the force necessary to overcome the powerful muscles of the thigh, this force being applied through strips of cloth put on the thigh in the form of a clove hitch (Fig. 6).

Incidentally, not so long ago this same hitch was described by Collins and since then it frequently has been referred to as the Collins hitch, but Hippocrates had described it as

Fig. 3. Applying the splints on the seventh day. First the two bandages have been put on, then the waxed pads, the bandaging to fix which can be seen under the splints. (After Scultetus.)

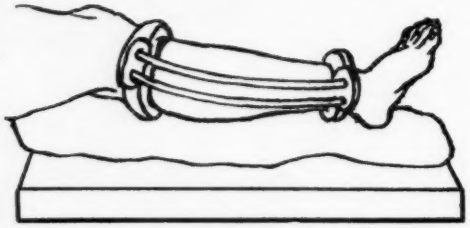

Fig. 4. Splint for leg fracture described by Hippocrates. Made of elastic rods fitting into loops on shackle-like pads above the ankle and below the knee. (After Littré.)

being an old form of knot which had been used by sailors for many years, and called attention to the fact that it would not slip.

There were fracture tables and portable fracture tables with perineal rests, ratchets, screws, levers and windlasses, and Vidius calls attention to the fact that the perineal rest must be well padded to avoid damage to the soft parts against which it presses (Fig. 7).

The scamnum described by Vidius for obtaining traction and countertraction embodies the same general principles. Hippocrates describes a fracture box (Fig. 9) although he does not advise its use.

Hippocrates says that the man who presumes to treat fractures must be equipped to do so under any conditions. The men in the larger cities should have the heavier equipment which has been described, but the men in the smaller communities and the traveling doctors must adapt whatever they have at hand to fit their needs. He describes a fracture table improvised from a ladder such as might be found in any household, by which

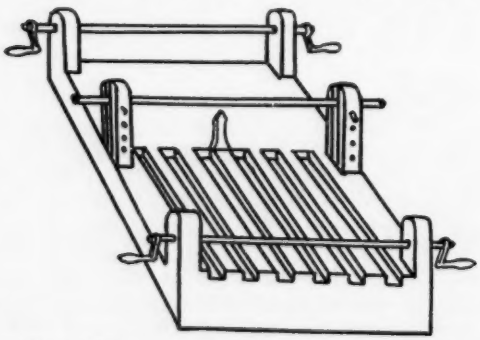

Fig. 7. The scamnum of Hippocrates. (After Littré.)

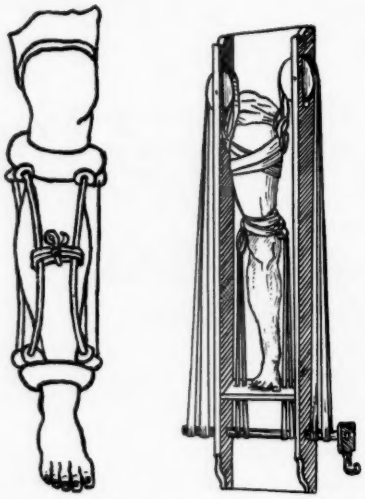

Fig. 5, left. Top view of same to show the tying together of the two top rods.

Fig. 6. The glossocomium of Galen, applied for fracture of the thigh. (After Vidius.)

the same traction and countertraction may be exerted (Fig. 10). For instance, in fractures near the elbow traction is applied by means of a clove hitch attached to the wrist. This in turn is acted upon by the system of pulleys seen in the illustration. Countertraction is

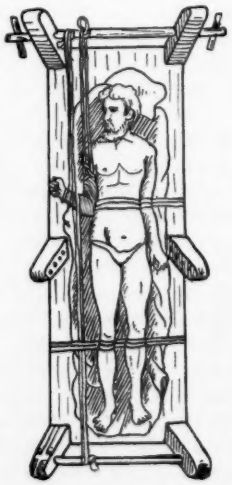

Fig. 8. The scamnum in dislocation of the elbow. (After Vidius.)

Fig. 9. Box splint or "canal." (After Scultetus.)

maintained by a rung of the ladder pressing firmly in the axilla on the injured side. Similarly, in reducing a fracture of the lower limb, the extension is applied by a clove hitch and counterextension by bands passed between the thighs and attached to the upper end of the table so the patient may not be displaced by the powerful pull necessary.

It is quite evident, therefore, that even in those days there were many methods. Hippocrates urges the practitioner to use the method which is best fitted to reduce the type of fracture with which he is dealing, and if one method does not work to try another. In his third book he cautions that "*extension of fractured or dislocated bones is not to be delayed to the third day but is to be carried out on the first day;* that slings may be used for some fractures in the upper extremities, but in the lower extremities fractures must be maintained by splints; that there must necessarily be great distinction drawn in the prognosis between simple fractures and compound fractures; that the alinement of bones must be regulated according to nature; that the line of the hand and arm in fracture of both bones of the forearm should be carefully studied; the forearm should be at right angles to the upper arm, but in fracture of the leg the straight position is preferable; that movement must not be allowed until the fracture is solid; and that extension must be made and maintained in a straight line"—that is, in the long axis of the bone. He says that the extension should be most powerful in the thickest bones with the greatest flesh, or in the forearm, having recognized that the muscles of the forearm are more irritable and active than many others of like size and bulk. He also calls attention to the fact that elevation reduced swelling; that in compound fractures it is impossible to tell

Fig. 10. Reduction of both bones of the forearm at elbow.

whether the bones will heal or whether the fragments of flesh and bone will be detached. He cautions that the fragment of bone which protrudes and is loose should be sawed off because it will die, will be extruded, and will prolong the convalescence; that if the flesh is completely torn from the bone it will die and become dried and exfoliate. Also we see that five centuries B.C. the statement is made: "When a bone is broken fairly across it is more easily treated, but when broken obliquely it is more difficult to manage." For the most part, Hippocrates says, in the case of the clavicle there is little disability resulting, but there is practically always a lump at the point of fracture. The differential diagnosis between a dislocation of the acromioclavicular joint and a fracture of the clavicle is also clearly made.

Prognosis as to time of healing is much shorter than would be given today. Hippocrates says that 40 days for fracture of the humerus can be expected, but if the fracture is not healed in that time the patient should be kept on a stricter diet for a longer space of time; he does not describe the diet, however. He cautions about frequent examinations, especially of the bones of the forearm, and says that when they are once put in place they

should be left there and not disturbed. He puts the period of convalescence at 30 days, but adds that there is nothing precise about this matter, "*for one constitution differs from another and one period of life from another.*" With regard to the femur, he says nothing should be omitted in order that the parts may be properly extended and put in a straight line, for, says he, it is a matter of great disgrace in an injury to exhibit a short thigh. In the arm where shortening might be concealed the mistake might not be noticed, but a shortened thigh bone would exhibit the man maimed. All these principles were laid down more than two thousand years ago, before anatomy and physiology were known. What keen observations and clear recording for colleagues and for posterity!

This knowledge recorded by Hippocrates was carried to Rome along with other Greek culture. Medicine and surgery was not a popular vocation among the ancient Romans. Theirs was a mercenary semi-civilization, and medicine did not offer in those days, any more than now, too much compensation for the time, skill, and labor involved in its study. The majority of the noted surgeons of the day were Greeks, either slaves or freemen. Celsus, though not a medical man, compiled a huge encyclopedia of the then current knowledge, most of which had come from Greece. In the first century A.D., Martial referred to the fact that Hermes was recognized as the best surgeon for fractures, and remarked that there were many specialists, some for enlarged tonsils, some for the removal of brands from slaves, etc.

Galen, 130 to 200 A.D., makes three commentaries on Hippocrates' account of fractures and offers some suggestions from his own experience, which doubtless was extensive, inasmuch as he was surgeon to the gladiators. A recently discovered statue, presumably dating from the time of Galen, represents the partially dissected body of a Gibraltar ape, the anatomy of which, as we know, differs little from that of the human body. It may be assumed that not only Galen but his predecessors as far back as Hippocrates and even farther, studied anatomy in this manner, although in ancient Egypt the destruction of the body meant the destruction of the soul also. It does not seem possible that Hippocrates could have gained his knowledge of the anatomy of the body without the aid of dissection, and after all, there were plenty of slaves and criminals in those days, in whose bodies no one had any particular interest, and in their souls, less.

From the fall of the Roman Empire in the 3rd and 4th centuries A.D., the long period of the Dark Ages of Europe intervened until the dawn of the Renaissance, and during this period nothing of note pertaining to fractures was written or described. The Church, always jealous of its perquisites, was responsible for the practice of medicine as a whole and guarded its secrets, and while there must have been many fractures in those centuries of almost incessant warfare, nothing of importance appears to have been recorded. An Arabian authority in the 10th century emphasized the importance of crepitus in the diagnosis of fractures, and at about the same period another authority advised sawing off the ends of fragments in non-union and described fractures of the spine resulting in paralysis. The science of medicine in the East far outstripped that of the West. Europe was peopled with barbarians during that period and the culture and enlightened ideas that brought her out of the Dark Ages were an importation from the East by the Crusaders. Previously the Moors, who conquered Spain, had brought much of the ancient knowledge of the East with them. The great Alexandrian Library probably provided the basis for their medical culture.

In the 15th century, the barber surgeons of France were given an examination on the care of fractures and dislocations, which incidentally was conducted in public before the mayor and other dignitaries. What the mayor knew about fractures no one has disclosed. Paré's work in the following century is well known, but it was Vesalius, whose work was published in 1543 when he was only 29 years of age, who laid the basis for our present understanding of anatomy. However, for many years fractures and dislocations were cared for mostly by bone-setters, although the army surgeons had considerable experience. I am

unable to find any understandable description of the methods of the bone-setters, or any reasons for their doing what they did. In England and Wales the profession apparently was hereditary in comparatively modern times. Watson has recorded eight consecutive generations of bone-setters in Wales. The paternal great-grandfather of Hugh Owen Thomas (1735–1814) was apparently the most celebrated and skilful. A generation later there were 21 practitioners in the Thomas family, representing both sexes. Evan Thomas, the father of Hugh, set up as a bone-setter and practiced among the neighboring farmers. In this country the Sweet family of Rhode Island was famed for their skill as bone-setters, and Comstock recorded that one of them successfully treated DeWitt Clinton of Erie Canal fame, after 52 physicians and surgeons had failed. That fracture must have been treated by all the doctors in Rhode Island and some from neighboring states, and the bone-setter probably had as good a press agent as a certain foot-twister of today.

The first modern book on the treatment of fractures and dislocations was written by Sir Astley Cooper in 1822, and by 1839 this publication had had 10 editions. This work undoubtedly was responsible for the revival of interest in the treatment of fractures, at least in this country. In 1827, Nathan R. Smith devised suspension in fractures by the long anterior splint and in the same year J. Kearney Rodgers was the first to wire ununited fractures successfully, although it had been attempted in 1805 by Moreau in France. Two years later Daniels, of Georgia, published his work on weight and pulley traction for fractures of the femur, which he had been using since 1819. This is the first record of suspension. Barton wired fractures of the patella in 1834: Detmold began drilling ununited fractures in 1850, and Brainard of my own city followed him 4 years later. In 1857 Van Ingen advised elevating the foot of the bed to make the body act as countertraction in fractures of the femur, in addition to Daniels' weight and pulley. Buck's well known extension appeared in 1851, and Hodgen's equally well known splint appeared in 1863. In the previous year, Hunt, of Philadelphia, introduced sandbags. The starch bandage was invented in 1840, and the plaster-of-Paris cast by Mathieson, an army surgeon of Holland, about the same time. How many sleepless nights were spent, and how many needless gadgets were invented *before* these steps is not recorded, but worthwhile ideas do not usually spring full blown from the brow of the gods.

John T. Hodgen, who was a graduate of the University of Missouri, a general practitioner and afterward surgeon general of Missouri, had a decidedly mechanical turn of mind, and undoubtedly was far in advance of the current practice of his day. He emphasized the extreme folly of urging any specific apparatus in the treatment of fractures of any particular bone, and said it was too apparent "to require a remark in refutation." With reference to his famous splint, he said it was a modification of the wire splint of Smith and Swinburne's extension, with his own strip bandage supports used in the cradle splint.

In the 1860's Hugh Owen Thomas described the splint with which we are all so familiar. He had established himself in the great port of Liverpool, where he came to be surgeon for 28 labor unions. It was in this practice that he gained his vast experience in the treatment of injuries, especially fractures. My former teacher, Professor John Ridlon, one day counted 160 cases coming to Thomas' clinic. Sunday was set aside for his charity clinic. He had no hospital appointments and his splints and many other forms of apparatus were made and fitted on his premises. Probably he did more work in this line than anyone of his generation, and his pupil, Sir Robert Jones, until his death carried on the work and ideals of his teacher. In the treatment Thomas stressed the importance of enforced, uninterrupted and prolonged rest. He pointed out that the circular compression induced by plaster interfered with the true conception of rest: hence, in 1867 he devised his famous splint, which today I believe is adaptable in original or modified form to the proper treatment of more fractures of the long bones than any other splint ever invented. I say this without fear of contradiction. It can be used in the reduction of fragments and also for

their maintenance in reduction. It can be adapted for suspension or ambulatory treatment, and when properly used is of the greatest service.

In 1895, the discovery by Wilhelm Konrad von Roentgen of the ray which bears his name marked the next great step forward in the diagnosis and treatment of fractures. Robert T. Morris, of New York, said "When the X-ray came into use as a diagnostic resource, it was for surgeons what a stereoscopic view of the soul would have been for the theologians. It was the X-ray that taught us the difference between anatomical position and a functional result. We worried overmuch when the picture showed the ends of the bone out of complete contact, and forgot that these ends had wonderful ways of uniting in those days prior to the time the X-ray permitted us to see them." I want to add, however, that this does not preclude the desirability of an ideal anatomical result, because undoubtedly there is a larger percentage of good functional results when the fragments are brought into anatomical re-position than when there is some degree of overlapping or misalinement.

The section on surgery of the British Medical Association in 1910 recommended a report on the ultimate results obtained in the treatment of simple fractures with or without operation, and this review embraced a period from January, 1906, to December, 1910. There were gathered from 20 hospitals throughout the United Kingdom, 1016 records of patients under 15 years of age, and 1580 records of patients over 15 years of age. Good results were obtained in 45.4 per cent of the cases without anatomical re-position, but in 66.3 per cent of cases, good functional results were obtained by anatomical re-position. The conclusions were that no method, either non-operative or operative, which does not definitely promise a good anatomical result, should be accepted as the choice.

The report says that mobilization and massage by themselves have not been found to secure a high percentage of good results; they are, however, valuable supplementary methods. Methods which secure re-position and absolute fixation of the fragments yield better results than those which fall short of this. Imperfect fixation by wire or other suture has been found unsatisfactory for long bones, except in cases in which the olecranon process is involved. The conclusion is followed by the statement that *operative treatment should not be regarded as a method to be resorted to after failure of non-operative measures, and that to secure the most satisfactory results from operation, it should be employed as soon as possible;* but it must be appreciated that operative treatment requires special skill and experience, and in addition, such facilities as will assure asepsis. A considerable portion of the failures recorded were due to infection.

Great stimulus was given in this country to the operative treatment of fractures by the visit, in 1910, of Sir Arbuthnot Lane, and for a number of years following there was promiscuous fixation of fractures with Lane plates by persons who had had no training in the treatment of fractures or in surgical technique. The result was the frequent occurrence of osteomyelitis due to infection following operative treatment of fractures employing fixation by steel plates. This is still one of the favorite forms of fixation. Unquestionably, it is applicable to certain cases. Probably the reason for its popularity is not that it is the method of choice in most instances, but because the application of the plate is easy and requires small outlay for equipment, and little skill. One needs nothing but a plate, some screws and a screwdriver, a will to operate, and sometimes, it is to be feared, a lack of conscience and an absence of a feeling of responsibility for the end-result. I once asked Dr. John B. Murphy how many Lane plates he removed, and his answer was: "Eight out of every ten I put in, and I don't know who takes out the other two." It would seem that a method which necessitates two operations and the insertion of an irritating material could in many cases be avoided; and certainly to make an incision over a bone which lies close under the skin, and place a foreign body immediately under the incision—and this is not infrequently done—does not display good surgical judgment. So here again we have a question of experience and judgment in the use of a valuable method, but a method which is to be selected for the individual fracture.

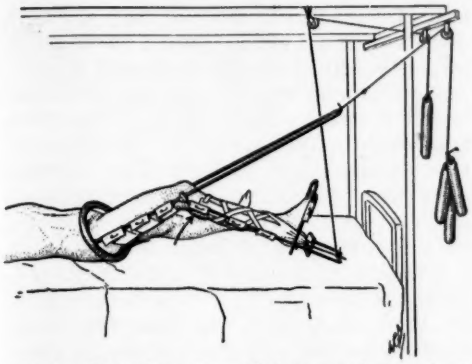

Fig. 11. Skeletal traction applied through the lateral and crucial ligaments. Traction on the end of the Thomas splint and points of pressure on the calf near the upper end of the tibia.

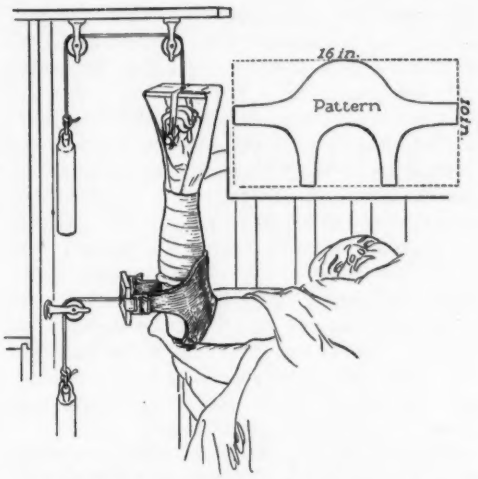

Fig. 12. Skeletal traction through the lateral ligaments of the elbow applied through the upper forearm to the lower end of the humerus.

In 1909, Steinmann demonstrated his famous nail, by means of which traction could be applied directly to the bone. During the great war, however, calipers were devised to take the place of the Steinmann nail, which has this handicap: should infection occur in the presence of the nail it may extend into the tunnel through which the nail is driven, a tunnel of infection through the middle of a bone is not easily handled and may result in permanent damage. By means of calipers the same skeletal traction can be secured and in some cases with some advantage over the nail, and should infection occur it is usually localized to the surface points of contact instead of going through and through. This does not mean, however, that the Steinmann nail is not the method of choice in some cases.

Kirschner's wire was introduced in 1909; a method of skeletal traction exerted by piano wire stretched tight and held in a U, through which traction could be maintained. This many times has proved to be a great advantage over both calipers and Steinmann nail. No preliminary drilling need be done because the wire acts as a drill, and there is less likelihood of infection because the foreign body introduced into the bone is small. Kirschner wire, in my opinion, has been one of the greatest contributions to the treatment of certain fractures that has appeared in the last generation. Skeletal traction may also be maintained on the femur by traction through the lateral ligaments of the knee (Fig. 11, femur) and on the humerus through the ligaments supporting the elbow, if these joints are flexed and pressure is applied close to the flexion angle (Fig. 12, elbow).

The vast development of industry and high speed transportation has brought about a tremendous increase in the number of fractures in the last 25 years. Since the advent of the automobile, even during the early days of 15 and 20 miles an hour speed limits, we have encountered many unusual types of fracture unknown to our predecessors. In 1917, Dr. Scudder established a fracture service at Massachusetts General Hospital. Five years later, realizing the tremendous disability caused by improper treatment of fractures, and the lack of understanding of fractures which were occurring with greater frequency, he called a conference in Boston, attended by 25 surgeons, and out of this conference grew the Fracture Committee of the American College of Surgeons, which was established in 1927 with Dr. Scudder as chairman. This committee has worked for the enlightenment of the profession to the end that fractures would be treated more intelligently and that there would be improvement in results. The committee has established standards for

equipment in hospitals, and, wherever possible, has persuaded the hospital staff to install a special fracture service to be headed by men especially interested in, and equipped to treat, fractures from their inception. Fractures, however, do not always occur under conditions to bring them within the intent of the Committee; they have a tendency to occur at inopportune localities. A large percentage fall into the hands of doctors who have not mastered the fundamental principles underlying treatment. The terrific violence which causes many of these injuries has produced many new and hitherto unheard of fractures—fractures which the textbooks cannot describe, because each one is a law unto itself and must be treated as such.

Fractures are mechanical in origin, and are controlled by mechanical factors, and the man who undertakes the treatment of fractures should have a thorough knowledge of mechanics, the fundamentals which underlie the production, the reduction, and the retention of the fracture at hand, and the reason for applying the mechanical means of maintaining the fragments in position. Unless the surgeon has an understanding of the anatomy and the physiology of the parts, as well as the pathology, he will continue to treat fractures by somebody's method. Fractures never have been reduced by brawn without a liberal mixture of brains. We have had innumerable kinds of apparatus invented and described for the reduction of fractures, and if one were to have one-tenth of it in his equipment he would spend half his income and might be able to use only one piece a year to advantage. Splints have been devised that look beautiful in the picture—shiny and efficient, with many straps and buckles—but when applied, frequently it is found that the straps do not give support in the right place and the splint cannot be held at just the particular angle necessary to fix that particular fracture in the most favorable position. The soft parts cannot stand the pressure, the patient is too fat or too thin, or the splint will not stay in position for one reason or another. Traction and countertraction are difficult to maintain, and in ambulatory treatment practically impossible, and when it is necessary to maintain these the patient should be in bed. Because a patient *can* walk around with a fracture of the arm is no reason why he should be allowed to do so. Suspension with traction and countertraction is still the most valuable form of treatment, and when I say suspension I do not mean traction and countertraction alone. I mean suspension which allows freedom of motion of the body as a whole while still maintaining the line of traction on the fracture.

Boehler's work has given great impetus to the use of many forms of mechanical apparatus, particularly to the skin-tight cast. In the hands of Boehler they are undoubtedly excellent. Boehler knows how to choose the case to which his methods are applicable. But when one sees an attempt to maintain traction in a straight line on a fractured femur, by means of an apparatus which rests on the bed while the patient tries to change his position or allow usual nursing care, the lower fragment fixed to a support which rests on the bed and the upper fragment fastened to the body which is not fixed, one is inclined to wonder whether the surgeon understands what he is attempting to do. This is what happened in the ancient Egyptian cases previously mentioned; the lower fragment is well immobilized up to the point of fracture and the upper fragment is allowed to ride free and engage in all motions in which the body engages. When one sees five Kirschner wires driven through an extracapsular and intertrochanteric fracture of the femur, up into the hip, to maintain a fracture in position which could easily be maintained by traction and abduction, he wonders whether gadgets are not taking the place of good sense.

Ridlon observed that Thomas' success was due to the application of right principles rather than to the use of this or that apparatus; this corresponds to the opinion of Hodgen, and to the teaching of my old friend Dr. G. G. Davis, of Philadelphia. Dr. Davis was one of the greatest anatomists of his time, and from his teaching his pupils gained an insight of anatomy far beyond the abstract—they saw a living, pulling, bending, circulating, sensitive anatomy, where one looked at the skin and saw beneath it the fascia, the muscles, the ligaments, the bones, their interrelationship,

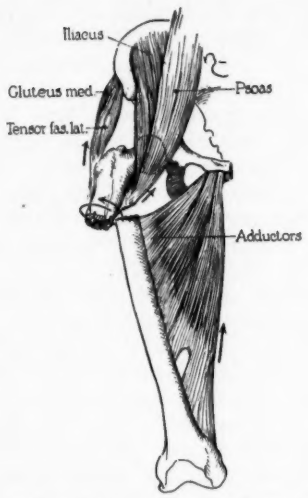

Fig. 13. Diagram of muscle pull controlling fracture of the femur at or near the junction of the upper and middle third, illustrating the principle "the fragment which can be controlled should be brought into alinement and rotation with the fragment which cannot be controlled."

Fig. 14. Diagram of muscle pull applied to fracture about the middle of the femoral shaft, demonstrating the displacing effect of adductors on the lower fragment.

their activity, their nerve supply, their viability. It is only by this conception that one visualizes a fractured femur at the junction of the upper and middle third, with the upper fragment being externally rotated by the powerful external rotator muscles and flexed by the ileopsoas (Fig. 13, femur); a fragment too short to be controlled by any means other than operative fixation. Then one realizes there is a long lower fragment that can be controlled by traction, suspension, and rotation, and that the tension of the obliquely pulling adductors can be relieved of the spasm created by the irritation at the point of fracture if there is careful balancing of traction against their displacing effect (Fig. 14). This great adductor group can be prevented from producing an angulation at the point of fracture if the limb is properly suspended and weight applied sufficient to overcome its pull. One will also see immediately that it frequently is impossible to control a fracture of both bones of the forearm occurring between the supinators and pronators, because of the great angulating pull of these muscles, and will resort to open operation before there is fibrosis, tissue, or callus around the site of fracture and contracture in the muscles attached to the fractured bones, which almost precludes even the operative replacement and retention in anatomical alinement and rotation. He will know that a fracture of the surgical neck of the humerus, put up in full abduction, has such a tremendous pull placed on the upper end of the lower fragment by the pectoralis major, that it cannot be held by anything other than lateral traction, which it is impossible to apply because of the brachial nerves and arteries that lie immediately between the skin and the medial surface of the bone (Fig. 15, shoulder). If these and many other principles were understood and were borne in mind when any fracture is being treated, there would not be so many difficulties and so many bad results.

I quote from an article written by Dr. George Crile, which appeared in the *Annals of Surgery* in October, 1919, after his experience with many war injuries. He entitled it "The Good Surgeon."

> The surgeon and the pathologists who for four years have intensively studied war wounds have formulated many theories of treatment—many apparently contradictory theories. Thus there have been presented the claims of the value of various chemical agents against those of no chemical agent; of moist dressings against dry; of heat against cold; of frequent dressings against infrequent dressings, and of no dressings against both; of sunlight and of

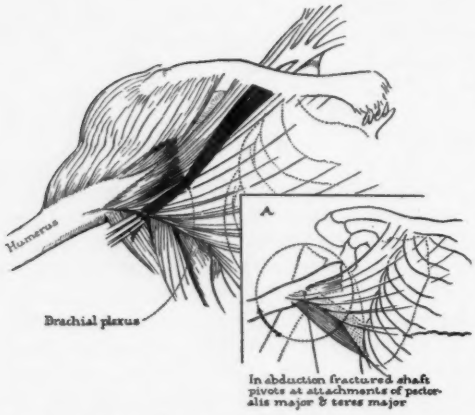

Fig. 15. Fracture at the surgical neck of the humerus, demonstrating the action of the adductor muscles of the humerus becoming a fulcrum which causes the upper end of the lower fragment to descend as the lower end of the same fragment is brought into abduction. This involves not only displacement of the upper end of the lower fragment but may injure the brachial plexus by angulating it over the sharp edge of this fragment.

electric light against occlusions; of immersion against hot air; of bacteriological control against clinical judgment; of vaccine toxin and foreign proteins against normal reaction; of wound inoculation with harmless organisms against wound sterilization; of isotonic against hypertonic solutions; paste has competed with paste; bipp with ip, sap with both, and chromic paste with all.

Does not this intensive study of infection in war wounds for this comparatively short period equal and recapitulate the more leisurely study of infection during the 30 years since Lister first proposed the carbolic spray? And is there not slowly emerging from the present conflict of opinions the same fact as that which emerged from the post-Listerian period—that the one agent of successful surgery, whether war surgery or civil surgery, *is the good surgeon?*

We cannot hope that all surgeons who treat fractures are good surgeons in every line, and the definition of a good surgeon is very broad. The surgeon, however, who attempts to treat fractures should consider first whether he is the type of surgeon to treat the fracture confronting him. Has he the fundamental knowledge and the mechanical skill to meet the exigencies of the case? His conscience must be his guide, and if his conscience misleads him to attempt something that results in a crippling deformity which could have been prevented, he will have erected a monument that probably some day he will wish to hide, and will have made somebody's life a burden that could have been a pleasure. There are no splints which reduce fractures automatically.

Looking back 25 centuries to Greece, we find the same principles described in the treatment of fractures that we use today, or should use. Civilization has progressed in some ways, but the anatomy and the temperaments of people have not changed. We have at our command X-ray equipment and mechanical appliances that the ancients did not have. We also have many types of fractures, due to the speed of the times both in industry and in transportation, which they seldom, if ever, met. But if we use our knowledge of anatomy and physiology and build up fracture treatment on the basis of this knowledge, using the X-ray, operative surgery and the approved mechanical devices, there is no reason why there should be as many poor results in the treatment of fractures as there are today.

Hippocrates' teaching is still the best teaching. A fracture should not be allowed to go to the second or third day but should be reduced, and properly reduced, as soon after it occurs as it is possible to apply the reduction apparatus, which is thought out to meet the needs of that particular case—whatever they may be. Let's forget any particular method, and when we see a fracture, look through the skin to the tissues that lie underneath; weigh the value of any method for that particular fracture, or invent a new one, and reduce it once and for all so that it will stay reduced. Principles stand from generation to generation; gadgets come and go. Let us go and sin no more!

ADRENAL CORTICAL TUMORS[1]

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CORTICAL adrenal tumors have produced marked changes in physical characteristics and in metabolism. Some changes which resemble these have been described as caused by certain tumors of the pituitary (13), the pineal gland (58) and the ovary (7). A study of adrenal cortical tumors with the metabolic and secondary sex changes is presented.

Tumors arising from the suprarenal gland can be classified as: (a) those arising from the various layers of connective tissue, or from blood vessels, lymphatics, or nerve structures within the gland; (b) those arising from the medullary cells; and (c) those arising from the cortical cells.

Of the tumors occurring in group A, those recorded are: fibroma, neurofibroma, myoma, osteoma, lipoma, hemangioma, lymphangioma, and melanoma. Goldzieher has classified the types arising from the medullary cells on the basis of embryology, into tumors from the sympathogone, sympathoblast or pheochromoblast cells, and those tumors from the sympathetic ganglion, or ganglioneuromas, and those from the pheochromocytes, or paragangliomas. Ewing has classified cortical tumors as hyperplasias, adenomas, and carcinomas.

Hyperplasias, or well defined nodules of cortical cells, have been reported as common. Goldzieher states that nodules are to be found in 33 per cent of all adults and that it is difficult to distinguish between nodular hyperplasia and small adenoma. Nodular hyperplasia has been suggested as being a regenerative process following infectious damage to the adrenal gland.

Adenomas vary in size from a pea to a goose egg or larger, are frequently bilateral, usually globular, and set off from the remaining adrenal tissue. They may be definitely encapsulated. The color is a sulphur yellow and often may be mottled with dark, pigmented brown or red areas. Microscopically the cells are those of the adrenal cortex. They may simulate those of the entire cortex, including pigment of the reticularis. In large adenoma, Goldzieher states that the structure may resemble the zona fasciculata. In cases with symptoms of hirsutism, Brostner and Vines state that they have found a deep fuchsinophil staining power in the cytoplasmic granules of the reticularis. Confirmation of this finding has been published by Goldzieher and Koster who state that the reticular layer is also widened. There is usually an abundance of lipoids. Lubarsch states that glycogen is scarce in these adenomas. The proliferation of the stroma may bring about a deceptive picture of the papillary growth but Prym states that real tubular or papillary structures are not formed—a feature which distinguishes these adenomas from the so called hypernephromas of the kidney.

Geschickter reports that most of the adenomas are asymptomatic and are found accidentally at autopsy. In his study of 72 adrenal tumors, 63 were so discovered. He states that the distinguishing characteristics of cortical adenoma are: definite cortical cells, tendency to lipoid degeneration, marked capillary network, pigment deposits, and the arrangement of the cells in cords and bundles.

Neoplasms of the cortex proper and neoplastic tumors developing from accessory "interrenals" are not common. Tumors arising from adrenal rests occur in various parts of the body: in the kidney, the liver, the pancreas, the retroperitoneal tissues, and in the testis and broad ligament. True renal tumors which resemble the adrenal cortex are considered by most to have nothing to do with the adrenals. The difference in these tumors has been well brought out by Ewing. In a real adrenal tumor, there is a loose relation of the cells to one another and to the stroma. Areas of diffuse growth, or indifferent

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spheroid cells, or spindle cells are practically unknown in renal tumors but are frequent in adrenal growths. Giant cells form in both varieties of tumors, perhaps to a greater extent in those of adrenal origin. Fraser states that the primary structure of the two tumor types is decidedly different, and that only secondary structures due to malignant change or degeneration can cause the renal to resemble adrenal growths.

Hypernephromas of themselves are thought to occur rarely in the adrenal. Ellis has estimated them at less than 2 per cent. According to Goldzieher, in the cells of adrenal origin the cytoplasm is foamy, granular, and interspersed with lipoid granules. In renal tumors the cells are remarkably clear throughout, resemble vegetable cells, and contain large globules or crystals of fat with hydropic fluid and little or no granular material. Hydropic vacuolation and an abundance of glycogen are two noteworthy features of renal carcinoma. Both are absent in the adrenal cell type, the glycogen content of which is usually negligible.

Tumors arising from the adrenal cortex proper are usually soft growths of a yellowish color with a tendency to hemorrhagic areas, and at times with areas of necrosis. They may vary in consistency, being more solid in some parts; occasionally may develop cystic areas following necrosis; at first are definitely encapsulated, but later may grow through the capsule and invade other tissues. They are most commonly reported as invading the kidney, which occurred once in our series (Case 5). The tumor may invade the kidney pelvis and the renal vein with thrombosis of the vena cava. When metastases occur, they are most frequently seen in the liver and lungs. Bone metastases, common in renal tumors, seem to be rare in adrenal tumors. Harris and Pflews, in reviewing the literature, reported that, in 15 cases at autopsy, metastases were found in the liver 5 times, the lungs 3 times, and the liver and lungs combined, twice. Stevens, in an analysis of 74 cases from the literature, found metastatic reports as follows: liver, 27; kidneys, 16; lungs, 14; skull, 11 (possibly some orbital skull metastases from medullary tumors of Hutchinsonian type); the opposite adrenal, 9; the peritoneum, 7; the brain, 5; the lymph glands—aortic, bronchial and mesenteric, 14; the pancreas, heart, mediastinum, and ribs, 3; the spleen and intestines, 2; and the ovaries, 1.

Microscopically, cortical adrenal tumors, at times, may resemble the zona fasciculata. This was apparent in our Case 1, without endocrine symptoms. In the cases with endocrine symptoms, the cells bear greater resemblance to those of the zona reticularis. This was reported by Brostner and Vines in their cases of hirsutism; similar findings were reported by Goldzieher and Koster, but not in definite tumor cases. In our Case 1, in 1930, this difference was noted in contrast to our Case 2 with endocrine change.

The adrenal is frequently involved in metastases, secondarily to other organs. Burke, in analyzing autopsy records of 371 cases with malignant tumors, found the adrenals involved in 49, only 2 of which were primary in the adrenals.

SYMPTOMS

Cortical adrenal tumors may be asymptomatic or symptomatic; symptoms varying according to sex, age, and the degree of malignancy. Definite adrenal cortical tumors are reported without any apparent endocrine changes and with only the presence of the tumor and symptoms of malaise accompanying it.

Langeron and Loheac classify the various symptoms of adrenal cortical tumors as follows: (a) tumors with endocrine symptoms; (b) tumors with only an abdominal mass; (c) tumors with metastatic masses; (d) tumors with arterial hypertension, either paroxysmal or continuous.

When adrenal cortical tumor occurs in the male before puberty, there is frequently an increase in muscular development, the so called Herculean type. Harris and Pflews report this occurrence in 60 per cent of the male children in their collected cases. With the muscular development, a marked growth of hair occurs on the face, body, extremities, and genitals. Rapid growth may take place early but is later replaced by ossification of the bones and absorption of the epiphyseal

cartilages. When the disease occurs before birth, closure of the cranial sutures has been reported. The dentition is rapid, and 1 case is reported in which dentition was almost complete at 6 months of age. The muscular development is frequently accompanied by marked athletic ability, out of proportion to the age of the individual. The growth of hair is usually dark, coarse, and at times so thick that the genital area resembles the ape more than the human, so completely is the skin hidden. There is a change in the skin in that it is more dry than normal, and the acne manifestations, so frequently seen at puberty, appear on the face and chest. Some cases develop duskiness of the skin of the face and hands. The external genitals increase to adult size, and premature puberty as well as paternity has been claimed. The picture is mainly one of premature maturity. Precocious tastes develop, as the fondness for smoking cigars seen in our Case 6, of prepuberty virilism which, however, was not proved to be a tumor of the adrenal. Premature senility has been reported in slow growing tumors. Precocious mental development has been reported in 5 cases with marked dullness in 2 (Harris and Pflews).

It has been stated that in the male after puberty, no further change toward masculinity is possible. In support of this, Hartman reported a case in which the symptoms were pain in the abdomen and chest with marked weakness, and with a mass in the right side of the abdomen, which on transperitoneal removal proved to be a malignancy of the adrenal cortex. Stevens reported a similar case following injury. Gibson reported a case with operation for tumor of the cecum with possible liver metastases, which on autopsy proved to be a right adrenal hypernephroma. From the autopsy records of Presbyterian Hospital, the history of Case 5 was obtained. This case presented shortness of breath, weakness and cough, with evidence of consolidation of his right chest. Aspiration of the patient's chest showed tumor cells, epithelial in type. Autopsy proved he had a carcinoma of the right adrenal cortex with metastases. Tremoliers reported a man of 25 years with symptoms of fatigue, fever, and sepsis, who died in cardiac collapse and who on autopsy, showed cortical malignancy of both adrenals.

In contradistinction to these cases of cortical adrenal tumors is the one reported by Macera in which the patient developed adiposity, an increase of hair over the normal, very large genitals, and suffered from polydipsia. Autopsy revealed cortical carcinoma of the adrenal with pulmonary metastases. An additional case with endocrine change was reported by Long and Gray of an acromegalic man of 45 years with pain in his hands and feet, edema and pigmentation of the hands and feet, and with bone metastatic tumors on X-ray examination. Autopsy showed a large right cortical adrenal malignancy, a very small left adrenal, generalized metastases of the tumor, and an overgrowth of the pituitary by atypical epithelium with no resemblance to the adrenal tumor cells. Weber, in addition, cited 2 cases from the literature in which endocrine changes occurred but not towards the adult male type. One was a case of Dr. J. D. Zum Bush: a young man aged 27 years had an enlargement of both mammæ with secretion, and on autopsy, a hypernephroma of the left adrenal cortex was found with multiple metastases. The other was a case of Bittorf-Matthias: a man of 26 years had dyspnea, hypertrophy of the mammæ and atrophy of the testicles. Later a tumor developed in the left side of the abdomen which, on autopsy, proved to be a hypernephroma of the adrenal cortex.

From these citations, if the observations are correct, the male after puberty may show some endocrine imbalance such as adiposity and increase of hair. At times, he may show the pigmentation and weakness associated with Addison's disease when both adrenals, or a solitary functioning adrenal has been affected. At times he may show similar changes with sepsis, if necrosis of the adrenal occurs. Rarely, he may present changes in the mammary glands (gynecomastia) similar to changes in chorioepitheliomas of testicular teratomas. However, the usual symptoms appear to be weakness associated with the malignancy and the presentation of the tumor in the abdomen.

In the female, when the disease occurs before birth or in early infancy, the symptoms

have been described as pseudohermaphroditism. Gallais, in his study of 67 cases presenting suprarenal lesions in the female, divided the cases into 4 types: (a) pseudohermaphroditism, (b) virilism suprarenal, (c) form menstrual, and (d) form obstetrical. He stated that in the pseudohermaphrodite, the virilism is developed to the highest degree. It appears in the genital organs giving the illusion of the male sex, with the sex characteristics clearly masculine. If it occurs in embryonic life, the result is hermaphroditism. Cecil cites Crecchio's case of an individual who was baptized as a girl, but brought up as a boy, and who apparently was masculine in sex until he died at 40 years of age. On autopsy, a uterus, tubes, and small ovaries were found with extreme hypertrophy of the adrenals. Cecil states:

> Such changes taking place after birth have led to the belief that congenital pseudohermaphroditism in the female is due to abnormal hypersecretion of the cortex during embryonic life. All degrees of such anomalies are found, from only slight enlargement of the clitoris to enormous enlargement of the clitoris, accompanied by atresia or total absence of the vagina. The internal genital organs are usually small and sometimes greatly deformed. Such deformities do not increase, nor is there a change toward the normal. It would seem that if such defects were the result of hypersecretion of the suprarenal cortex, it was rather early in embryonic life and that later the suprarenal would cease to exercise such abnormal control. With the exception of cortical tumors, I have seen no report of abnormalities of the suprarenals that might have been responsible for the condition. Removal of one suprarenal has failed to have any beneficial effect.

An additional review has disclosed no cases of pseudohermaphroditism in the literature that had changes in the adrenal except that of tumor.

In the female, highly malignant tumors occurring before puberty cause death before marked changes occur. This, however, is not a common occurrence and most cases seen have the characteristic syndrome toward masculinity. Obesity is frequently associated with the change. This change to obesity from slight to very stout, with the fat on the face and trunk, was described by Fox, Ogle, Bullock and Sequiera, Richards, Glynn and others. Muscular hypertrophy has been observed by Sézary and Loman, and Jump, Bates and Babcock, but it is not frequent. There is a growth of hair on the genitals followed by growth on the face, body and extremities. The mammary glands are reported to have increased in size. The skin becomes red, coarse, dry, and the acne of puberty frequently occurs. The voice becomes deep, often cracks, and the vocal cords on examination are reported as increased in size. Ossification of the epiphyses is frequently observed. The appearance is reported as sullen. Most of the children have been mentioned as bright but Harris and Pflews stated that the frequency of bright to dull was 5 to 2. The changes in the sexual organs vary from slight to marked. The clitoris increases in size and in appearance resembles a penis. The labia enlarge, especially the labia majora, and are deep red. The entire genital region, pubis, and thighs are frequently covered with thick, dark and long hair. As a rule, these patients do not menstruate even though the age of puberty has been reached. To this there are two possible exceptions: one, a case reported by Bullock and Sequiera of a girl whose menses began at 10 years; and second, a case cited by Cecil, the menses beginning when patient was 2 years old. Harris and Pflews have reported a fall as the traumatism that injured the adrenal in a child and which was followed by an adrenal tumor with symptoms.

In the female after puberty and before the menopause, the changes vary according to the rapidity of the progress of the disease. The first symptoms are usually scantiness of menstruation, followed by cessation. Frequently headaches occur at the time when menstruation should have occurred. When the menses cease, the cessation is complete. Associated with the absence of menstruation, there is a complete loss of sexual desire and an absence of libido. In some, there is the loss of normal feminine modesty; in others it is unchanged. Attraction to the same sex is reported by Holmes with a recurrence back to normal attraction to the opposite sex after removal of the tumor. In none of our cases was there any change in sex desire of a homosexual type. On close questioning there appeared to be a complete absence of sex

thoughts in the adults but the young woman (Case 3) was still attracted to the opposite sex. The menses returned after the tumor was removed. The return of sex attraction and libido occurred after resumption of the menses. If metastases occurred later, the menses ceased with the regrowth of the tumor (Case 2). Shortly afterward or coincident with the cessation of the menses, there is a marked increase of growth of hair, called hirsutism by Apert. The hair begins to grow on the face and the pubic hair changes from the feminine outline to the masculine. The hair on the face and body is uniformly dark, very coarse and long. The hair on the head becomes coarser and dry. One of our patients (Case 4), a woman of 36 years of age, began to become bald on the top of her head, resembling her male parent at a similar age. Hair may appear on the shoulders. Its distribution is frequently more marked than it is in the male. In one of our cases, a girl of 16 (Case 3), the hair was so profuse on the thighs, abdomen, pubis, and anal region, that the skin could barely be discerned through the mass of hair. As a rule daily shaving removes the hair from the face. When the tumor is removed the hair falls out and the feminine pubic line is re-established. The loss of hair is most pronounced at the menstrual periods, and the depilation is most marked while bathing. Replacement of the hair of the head with the type of hair previous to the onset of the tumor is reported.

The skin changes, becoming dry and coarse. A red face occurs frequently. Duskiness and redness of the face and hands is reported somewhat similar to that described by Cushing in basophilic adenoma of the pituitary. Acne of the face, chest, and shoulders occur. Pigmentation of the skin is reported by Fineblatt and, in a male, by Long and Gray. Striæ atrophicæ are observed on the abdomen and thighs, and in females who have previously borne children, those present become more marked.

Obesity occurs apparently more often with the less malignant tumors. The fat is more restricted to the trunk and the face and neck somewhat similar to the description in Cushing's syndromes. In more malignant tumors, the fat is later replaced by angulation and emaciation.

The voice becomes deeper and somewhat masculine. In young women it frequently "cracks" like a boy's at puberty. The vocal cords have been reported to have increased in size. After removal of the tumor the voice slowly returns to normal. Some cases show a rapid change especially as shown in our Case 3, where a phonographic record before operation was the index.

There are changes in the secondary sex organs but they occur more slowly than those of the menses and hair. In females still in the growth period, the clitoris greatly enlarges and may assume the appearance of a penis. In our Case 3, it had the power of erection to about 2½ inches and when so erect was strikingly like a boy's organ. The labia enlarge, especially the labia majora and assume a dark color. The vagina has not been reported as changed. The uterus has been reported as both normal and small. In most cases at operation the ovaries have been described as small and atrophic. On vaginal or rectal examination there is loss of the usual ovarian sensitiveness. After a successful removal of the tumor, the clitoris slowly diminishes in size, and the uterus, if small, may resume its normal size on resumption of the menses. The ovaries have been described as increasing in size upon palpation with return of the menses and with a return of normal sensitivity.

In the young females there is no normal development of the breasts but they resemble those of boys. In adult females there may be a reduction in the size of the breasts but after operation and cure, they return to their normale size.

Some patients develop masculinity in their muscular changes. The increase in muscular tone and strength gives them an athletic superiority as was so marked in our Case 3.

Changes in the mental states of these patients have been reported by Gallais. Patients may become emotional. Murray and Simpson reported that their patient was irritable and depressed as in our Cases 2 and 4. However, in 2 of the females in our series who had previously borne children, there was no

apparent diminishment of the normal maternal love and care.

Edemas of the face, feet, and hands have frequently been reported, especially in cases of rapidly growing tumors. Headaches, especially at the expected time of menses are of frequent occurrence. Weakness and palpitation of the heart have been reported at the same time. Shortness of breath was a frequent complaint.

Symptoms referable to hypertension are frequent. If hypertension does occur, it is apt to be continuous and not of the paroxysmal type as reported with medullary adrenal tumors.

Insomnia was the complaint in a case reported by Anderson. Epileptiform attacks occurred in a case reported by Meyer and Trumess. However, the patient died before a diagnosis could be made. This is not an uncommon terminal symptom of acute cortical adrenal failure.

In females past the menopause the symptoms naturally have no change in the menses. Increase in hair and obesity have been reported but no change in the secondary sex organs was noted. A case has been reported by Goldschwend in which emaciation in contrast to obesity, was the outstanding symptom, with hirsutism. In these cases there seems to be an entire loss of superficial fat, and it has been suggested by Cecil that the emaciation was produced by the destruction of the adrenal tissues.

An interesting phenomenon has been reported, called the Achard-Thiers type, in which, associated with adrenal cortical tumor, are symptoms of obesity, hypertrichosis, and diabetes. The various causes of the metabolic disturbances have not been established but so far have been attributed to a pluriglandular disturbance and not entirely to the adrenal tumor.

DIAGNOSIS

In cases without endocrine symptoms the tumor, as a rule, has been large enough to be palpable in the abdomen in the region of the kidney. Not infrequently this type produces pain. These tumors displace the kidney downward. The displacement has been demonstrated by X-ray and particularly by pyelograms. In the displacement, the upper pole is frequently pushed downward and inward with the hilum of the kidney facing downward. This is the reverse of the usual picture of a nephroptotic kidney, and does not resemble the congenital, unascended kidneys in which the kidney, usually unrotated, has the hilum facing anteriorly. In some cases, invasion of the kidney has been demonstrated by irregular compression changes in the pyelographic shadows in the upper pole. These cases have been difficult to differentiate by pyelogram from tumors of the upper pole of the kidney.

When the characteristic syndrome of "genito-suprarenalism" is present the diagnosis lies between tumor of the adrenal, hyperplasia of the adrenal, and possibly basophilic adenoma of the pituitary. Ovarian tumors, as arrhenoblastomas, are reported to have produced symptoms that might be confused with adrenal cortical tumor.

Hirsutism occurs in pituitary, ovarian, and adrenal tumors. Goldzieher and Koster state that of pituitary origin is usually silky, lanugo-like, and facial growth predominates on the cheeks; that due to abnormal ovarian function is universal and of typical masculine character; that due to adrenal cortical activity is characterized by coarse, dark hair, on the chin and upper lip, besides wide distribution all over the body.

The obesity of these glandular disturbances has some slight difference in the various types. The pituitary has been characterized as the girdle type of adiposity, the ovarian as generalized, and the adrenal as involving the body and not the extremities.

Tumors and enlargements of the adrenal have been diagnosed by X-ray, either through the density of the tumor shadow itself, or through the tumor displacing some shadow-forming organ, usually the kidney. Carelli in 1921, demonstrated that carbon dioxide infiltrated into the perirenal fascial planes would be of value in visualization of the kidney, kidney capsule, and adrenal. Langeron, in 1929, showed that intraperitoneal air would enable one to visualize an adrenal tumor by X-ray. Roux-Berger, Naulleau, and Condiates, in 1932, diagnosed a cortical adrenal tumor by aortographic X-ray using the method of Reynaldo dos Santos. They in-

jected 40 cubic centimeters of thorotrast into the aorta through the left lumbar route and brought about visualization of the arterial supply of the kidney, the tumor, and the spleen upon X-ray.

Since 1930 we have used the method of Carelli, modified as described in a previous article (8). This method has been of value in demonstrating both pathological and normal adrenals. The air injected into the perirenal fascial space was displaced by manual pressure around the adrenal areas, and then upon X-ray the air was shown infiltrating around the adrenal and upper pole of the kidney. It is possible to outline the adrenals and with the change in size, shape, and position of the adrenal shadows, to have a tenable diagnosis of tumor, and it is possible to determine whether or not there is the presence of a shadow of an apparently normal adrenal on the opposite side. Photographs of the negatives and tracings of the same are shown.

Of additional interest in the diagnosis have been the studies of hormones in the urine of patients with genitosuprarenal syndrome. In our Case 2, Kurzrok in 1930 found no prolan A in the urine but was able to demonstrate the presence of considerable quantities of a follicular hormone. Apparently this was the first time that this observation had been made. The first report of this finding was made by Frank in 1934 in 2 cases of adrenal cortical tumors confirmed by autopsy. In these cases, large amounts of female sex hormone up to 57,000 mouse units were found, with tests negative to pregnancy, and with no increase in the pituitary sex hormone. Later confirmation of these findings was observed in our Case 3, in which the follicle—stimulating hormone was negative, but the follicular hormone showed 8 rat units per liter. In one other of our patients (Case 9), with hirsutism but with no diagnosable tumor by air injection X-rays, a similar finding of 8 rat units per liter of follicular hormone was observed. In still another patient (Case 7), in which the differential diagnosis rested between a basophilic adenoma of the pituitary and adrenal change, and a normal sella turcica by X-ray and with bilateral enlargement of the adrenals by air injection X-rays, the follicular hormone varied from 3 to 8 rat units per liter. Of great interest also is the case of the boy (Case 6) with marked sexual precocity and hirsutism in which various amounts of a hormone (theelin) were found.

There is the possibility that these various tests may offer a help in the diagnosis of some of the syndromes in adrenal tumors, as suggested by Frank. Further observations will be necessary to determine their values in endocrine disorders and they may be of significance in tumors. The occurrence of these hormones in the urine in large amounts, in males as well as females past menopause should be, from the above observations, suspicious of adrenal cortical change.

It is interesting to note the prompt disappearance (5 days) of the follicular hormone from the urine shortly after the removal of the tumor (Case 2). It is to be regretted, however, that her symptoms recurred in 9 months with demonstrable pulmonary metastases, but no determination of the hormones in the urine was made.

Sugar tolerance tests have been suggested as an aid in the diagnosis of adrenal tumors but our experience reveals only 1 case with a lowering from the normal (Case 2). It is possible that in this case there might have been other factors governing this, apart from the adrenal cortical disease. No autopsy was obtained and the condition of the pancreas was not determined.

OPERATIVE TECHNIQUE

Three different routes of approach have been used for removal of the adrenals: (1) extraperitoneally, through the lumbar region; (2) transthoracic route; and (3) transperitoneal route.

The lumbar route with an extraperitoneal approach has been used extensively in adrenal operations by Crile. It has been used for removal of tumors by Mursell; Jump, Bates and Babcock; Kennedy and Lister; Murray and Simpson; Crosbie and Smith; Walters, Wilder and Keplar; and for hyperplasias by Goldzieher and Koster, and others. Walters, Wilder, and Keplar have done bilateral exposures of the adrenals to determine, first, the diseased side and, second, to be satisfied that

there was an opposite adrenal present. A similar procedure was used by Goldzieher and Koster in their obesity cases.

The transthoracic route has been used by Broster and Vines in most of their cases of adrenal genital syndrome. This, they claim, is the easiest approach in view of the fact that the adrenal vascular pedicle allows a slight range of upward movement. It has the disadvantage of creating an artificial pneumothorax. They also attempted a subdiaphragmatic route by fracturing the last rib at its neck and retracting this up with the diaphragm. This exposure, they state, is not so satisfactory. Inaccessibility, deep bleeding, delicate traction on a friable organ through what may be a spasmodically movable and confined space, are the main difficulties of this route. In the transthoracic approach it was first necessary to do a preliminary laparotomy for exploration of both adrenals by palpation, and then after recovery perform the main operation by the transthoracic approach.

In an approach to an adrenal with tumor, the ideal method should be ligation of the adrenal vessels, particularly the veins, before any manipulation of the tumor. With the tumor, the adjacent fascia containing the lymph vessels and nodes should be removed. As this requires an adequate exposure, especially if the tumor is large, we think it is best done transperitoneally.

In the past we have removed medullary tumors through the lumbar route with ease and also with great difficulty; but since we have removed the cortical tumors transperitoneally through the oblique, subcostal incision, the safety of the operation, its ease of performance, and the completeness of removal that is possible of attainment by this approach, commends itself as the most satisfactory. In addition, it is possible, by palpation of the opposite adrenal, to corroborate the findings of the air injection X-rays concerning the presence of an opposing adrenal. In fat subjects the information derived from palpation is often uncertain and the palpation of a mass combined with a shadow by X-ray are both only suggestive evidence of a functioning adrenal. We have used the vertical rectus incision on both sides as well as the oblique subcostal and feel that the latter gives a better exposure.

The oblique incision began at the ensiform and extended along the costal flare until adequate exposure was obtained, depending on the obesity of the patient. The exposure was facilitated by use of an elevated bridge on the table, situated so that the costal flare is opened and the subcostal area projected forward as often used in common bile duct exposure. The posterior, parietal peritoneum was opened to the right of the duodenum and across and above the colon. On deflection this exposed the adrenal and renal area.

The right adrenal presents more difficulty than the left because it enlarges to a considerable degree around the vena cava and its central vein is short and empties directly into the cava (Fig. 13). The vessels were first ligated and divided, and then the tumor was delivered with its fascia. The ligation of the veins on the left side was much easier because the central vein empties into the left renal vein (Fig. 14) and is directly accessible.

Manipulation of the tumor before the ligation of the vessels was avoided, first, to prevent possible metastases from that cause, and second, to prevent the possibility of large amounts of adrenal secretion being injected into the circulation. To this has been attributed the collapse that sometimes occurs immediately following the operation. Such collapse appeared to be a reaction similar to the injection of large doses of epinephrine. The retroperitoneal approach to the left adrenal was just above the colon, and care was taken not to injure the splenic vessels lying between the adrenal and the tail of the pancreas.

Transperitoneal adrenalectomy for tumors has been successfully used by Hartman, Collett, Neligan, Holmes, etc.

Cecil states that following removal of the tumor, it has been found in the literature that 39 per cent of the patients are reported to have died soon afterward of shock. Of the patients who have recovered, he states it has been reported that 66 per cent had severe shock. In our cases, 2 had a similar picture which was ascribed to adrenal failure. In 1, the failure was temporary and she recovered (Case 2), and the other died (Case 4). With this state

of shock there was marked elevation of temperature but the patient was rational and felt comfortable. The pulse was small and very rapid—over 160. The blood pressures were very low 55/45 to 68/48. In Case 2, the administration of large amounts of saline with ephedrine and daily transfusions for 2 days, brought about recovery. The improvements noted immediately after the transfusions, we thought, were possibly due to the hormone in the normal blood. The recovery after 48 hours was thought to be due to one of two causes: either the shock was from excessive adrenal secretion introduced into the blood at the time of operation, or the remaining adrenal was in a state of suspended activity and there was a deficiency period of adrenal hormone until the other adrenal began to function. From the time element and from animal experimentation, the latter would appear to be more probable.

In the fatal case, large doses of sodium chloride solutions were given according to investigations by Loeb, with transfusions and eschatin (a cortical adrenal extract). The collapse continued and the patient died in convulsions resembling those of adrenalectomized animals. This case was especially interesting because by air injection X-ray the patient's apparently normal adrenal was the smallest adrenal visualized in any of our air injection cases. Cases have been reported in which the recovery has been facilitated by cortin (Prather). However, if there is no remaining adrenal tissue, very large doses would be necessary to have any effect according to the experiments on animals. In about 30 per cent of the reported cases the opposite adrenal was either absent or inadequate to support life. In the other patients operated upon in this series, large amounts of saline and transfusions were administered although there was no evidence of collapse.

X-ray therapy has been reported by Apert and Bubost to have produced favorable results when applied to the tumor area in patients not operated upon. We saw no beneficial results from the X-ray therapy to the metastases in the lungs in Case 2. It is possible, since the adrenal cortex arises from the same anlage as the testis, that future investigation may prove that some of these tumors may be susceptible to the X-ray as are some of the testicular neoplasms.

CASE REPORTS

Here is a study of 10 cases. The first 5 cases had proved adrenal cortical tumors, the second 5 had symptoms suggestive or characteristic of the disease, but there was no demonstrable evidence of tumor.

CASE 1. Chart 69341. A.S., a single woman, Canadian, of Scotch ancestry, was admitted July 21, 1927, complaining of intestinal trouble. Her father had carcinoma of the lip and her mother had high blood pressure. Patient was the youngest of 6 normal children and had had the usual childhood diseases. Her menses began at 14 and were regular. For the last 8 to 9 months her menses were scanty and she missed the last period. Her present illness began in 1926 with severe right sided pain radiating across her abdomen, and with fever. She developed tenderness near the umbilicus. She was treated medically and made improvement. A second attack occurred in April, 1927. Her distress had become more marked and she felt a tender mass in the left upper abdomen. She had nausea and vomiting and a slight cough. She had noticed a slight increase of hair on her face and arms. She was thin, active, nervous, intelligent. Her abdomen had a large firm mass in the left upper quadrant and flank. Cystoscopy showed a normal bladder, normal ureters and normal functioning kidneys. Pyelograms showed a normal right kidney but a low left kidney with a dense mass above. Her chest and diaphragm were normal by X-ray. Blood count was practically normal, as was her blood chemistry. Blood pressure was 155/68. Wassermann was negative.

Operation was performed July 29, 1927, and a left upper rectus incision was made. The peritoneum was opened and explored. A large, round mass, covered with dilated veins, and the size of a very large cocoanut was in the left upper lumbar gutter. It was retroperitoneal, below the spleen and free from it. The mass carried the colon downward and outward on its anterior surface, and was separate from the kidney which it has apparently pushed downward. The posterior peritoneum was cut external to the colon around the splenic flexure; the colon was peeled off the tumor from without and above, down inward, mobilizing the colon. The inner border of the mass was freed and a large vascular pedicle of the tumor was exposed. This was just above the vascular pedicle of the left kidney. The pedicle was ligated and the tumor was freed, and removed from the lumbar gutter with surrounding areolar tissue. It was outside the renal fatty capsule, was grooved at its posterior, inferior surface where the renal vessels passed. The mass was not attached to the pancreas. The colon was sutured back into place.

The area from which the mass was removed was drained with a cigarette drain through the incision. The wound was then closed in layers.

The patient's condition was fair after operation. She was given hypodermoclysis of 1,000 cubic centimeters and a transfusion of whole blood, 500 cubic centimeters. She made an excellent recovery. Her wound healed well and she was discharged to return home on August 25, 1928. The patient improved at home until January when she had a recurrence of abdominal distress with loss of weight. An enlargement, nodular in character, was felt upon her liver. In February, 1928, she was operated upon in Nova Scotia, and a section of a mass attached to her liver was removed. This specimen received at the laboratory was submitted to the same pathologist who pronounced the tumor similar to the preceding one. Word was received that she gradually became worse and died in May 1928.

Pathological report. (S.P. 36423, hist. 69341.) The specimen is a tumor mass said to have been removed from the region of the kidney. It measures 17 by 9 by 5 centimeters. It is nodular and apparently encapsulated. The nodules vary from 0.5 to 3 centimeters in diameter. On section the nodular pattern is maintained throughout the growth. The tissue is dense, pale, tough with softer yellowish areas scattered through it. These are apparently areas of degeneration. A few of these are hemorrhagic. Nothing resembling kidney or ureter can be found. While the yellowish areas have the color of suprarenal tissue; nothing having the differentiated architecture of the suprarenal gland, can be found.

Microscopic examination. The tumor varies considerably in its morphology in various parts. In some areas it is differentiated, reproducing cords of epithelial cells with an arrangement reminiscent in turn of the zona fasciculata, the zona reticularis, and occasionally the zona glomerulosa of the cortex of the suprarenal gland. With the Scharlach R stain, the varying lipoid content of the different cells is easily apparent. In the differentiated areas, the individual cells tend to be polygonal with faintly acidophilic vacuolated cytoplasm, and centrally placed nuclei. The nuclear markings are clearly defined and occasional mitosis can be found; they average 1 to every 6 or 7 high power fields. The cell bodies are indistinct and often the cells appear confluent. The cell groups are supported by a delicate reticulin which passes out among them from the larger supporting fibrous strands, which in turn connect with the fibrous capsule. Although many vessels accompany these strands, they seldom contain red blood cells. Many areas of tumor tissue are necrotic.

Merging with the areas of partial differentiation are others in which there is little or no differentiation. The cells in these areas are either isolated or in small groups, varying greatly in size and shape. Many are elongated, and both undersized and oversized cell forms appear, the latter often with several nuclei. Mitoses average only 1 to every 6 or 7 high power fields. In both areas there is a tendency for the tumor cell masses to infiltrate the capsule and septa. No areas resembling true hypernephroma can be found. Fontana's stain shows no melanin. Laidlaw's silver reticulin stain shows that the tumor cells are silver positive, and they do not form reticulin. There is no iron-containing pigment nor are there any nerve fibers.

Diagnosis: carcinoma of the suprarenal gland (cortical type).

CASE 2. (Chart 249269.) L.F., 36 years old, married, born in Russia, was admitted April 1, 1929. She complained of headache, weakness, palpitation, and cessation of menses for 2½ years. She particularly complained of an excessive growth of black hair all over the body.

The family history was negative. She had had a normal childhood. Her menses began at 16½ years, were irregular at first but after she was 18, were perfectly regular. She married at 22 years of age. During the war she had a nervous breakdown. Two children have been born, the first in 1920, the second in 1926. She has always been well. Her menses became scanty 2½ years before admission and then ceased. She developed severe headache at the time she would ordinarily menstruate, and she gained in weight. After a year, hair began to grow thick and long all over her body, and she shaved frequently. Her face became reddened. The last 3 months prior to admission, she had shortness of breath and palpitation. For 9 to 10 months she had swelling of her ankles. There were no cyanosis, gastro-intestinal, or urinary disturbances. Since cessation of the menses, she had complete absence of sexual desire, whereas before she had been quite normal.

On examination she was found to be a sturdy, stout, extremely red faced woman, with dark, thick hair on her head and a dark straggly beard. There was slight puffiness of her eyelids. Her face had some acne marks. Her thyroid was not enlarged. She had a normal chest with full breasts. The skin of her chest, back, arms was covered with long, black hair among which were numerous acne pimples and scars. Her pulse was 120 to the minute. Her abdomen was obese and hairy with a male pubic hair distribution. After careful examination, a mass was felt deep in the right side. Her genitalia and legs were excessively hairy. The vaginal mucosa was cyanosed and the clitoris was larger than normal. Her cervix was soft and the uterus was larger and softer than normal. Her ovaries were not palpable and the fornices were less tender than usual. Her eye and muscular reflexes were normal, as well as muscle tone and control. Basal metabolism was plus 31. Red blood corpuscle count was 5,700,000; hemoglobin, 124 per cent (Sahli); white blood corpuscles 15,000; platelets 200,000; polymorphonuclears 75 per cent; lymphocytes 25 per cent. Blood nonprotein nitrogen was 41 milligrams per liter; urea, 36 milligrams; creatinine, 1.8, and sugar, 91 milligrams per liter. Wassermann was negative. Her eye grounds and perimeter test were normal. X-ray

examination of the osseous system revealed no abnormalities. Cystoscopy showed a normal bladder and normal renal function. Pyelograms showed the right kidney low, with the hilum facing downward as if the kidney were pushed down. Injection of air (300 cubic centimeters) into the perirenal space, followed by X-ray examination showed a large mass above the right kidney, apparently pushing a normal sized kidney downward (Fig. 2).

A glucose tolerance test on April 8 with 100 grams of glucose showed an increase of blood sugar per liter up to 20.9 from .88 in 1½ hours with an appearance of 4+ sugar in the urine. The same day, the patient showed a blood cholesterol of 15 per cent; lysin phosphorus of 7.1, and lecithin of 177.6. Bleeding time was 1½ minutes; clotting time, 45 seconds. Fragility test was normal to controls. Her oxygen capacity of 226 volumes showed a hemoglobin of 113 per cent.

The Aschheim-Zondek tests for pregnancy were negative on April 18. Urine tested on mice by Dr. Kurzrok showed considerable quantities of ovarian hormone (follicular stimulating estrin).

X-ray film of the skull showed a normal sella turcica. Her blood pressure varied from 195/105 to 160/110.

Diagnosis of tumor of the right adrenal cortex was made and operation was performed on April 21 under gas-oxygen anesthesia. An upper right rectus incision was made and the abdomen was explored. The liver was very large and low; the uterus was small and soft, and both ovaries were very small and firm. There was a large retroperitoneal rounded mass above and separate from the right kidney, and directly above the right lobe of the liver. The mass was firm and felt fixed. The area of the left adrenal was palpated and sufficient tissue was felt, but no evidence could be definitely obtained as to the adrenal. The liver was lifted upward and the posterior parietal peritoneum was opened, the hepatic flexure and the duodenum being deflected inward and downward. The tumor, reddish in color, was outside the renal fascia. The tumor was removed without difficulty except where the venous pedicle apparently joined the vena cava near the liver notch. Here the large size of the liver made visualization difficult. However, the tumor was dissected off the vena cava and the large vein was ligated near the vena cava. The artery to the tumor was cut off just above the renal artery from the aorta. The tumor space was drained by a stab wound through the flank. The peritoneal attachments were replaced and closed, as was the anterior wound.

Her condition immediately following operation was fair and she was given a clysis of 1,000 cubic centimeters of saline. The next day she presented a peculiar condition of being apparently in good mental state, rational and with a feeling of well being, but with a fine thready pulse of 160 plus, a temperature of 103 degrees and a blood pressure of 55/45 on the left arm and 62/48 on the right arm. She received 700 cubic centimeters of glucose and later,

Fig. 1. Case 2. Adrenal cortical carcinoma.

600 cubic centimeters of whole blood. Her pulse dropped to 140 and her blood pressure was 128/80. Her temperature that night was 105 degrees and her pulse 150. She was given 2,000 cubic centimeters of saline with 1 gram of ephedrine during the night. Her hemoglobin was 75; red blood corpuscle count, 4,830,000; white blood corpuscle count, 26,000—polymorphonuclear, 77; lymphocytes 17, eosinophils 1, myelocytes 4. The second day her blood chemistry showed urea, 40.6; sugar, 154; cholesterol, 495; carbon dioxide, 51.3. Her blood pressure again dropped to 54/28 with a pulse of 165. She was given another transfusion of 500 cubic centimeters of whole blood. Following this her blood pressure rose to 126/90 and her pulse went down to 130. The third day her hemoglobin was 75 per cent; red blood corpuscle count, 4,500,000; white blood corpuscle count, 11,200—polymorphonuclear, 80 per cent. Blood chemistry showed urea 58; creatinine, 3.76; uric acid, 6; sugar, 148; chlorides, 495; and carbon dioxide, 49.1. She was given a clysis of 2,000 cubic centimeters of saline with 1 milligram of ephedrine. Her blood pressure fluctuated between 164/98 and 154/90. She was rational and felt very well. The fourth day her blood pressure remained between 145/80 and 160/100. Her chest was negative. She felt well. On the fifth day,

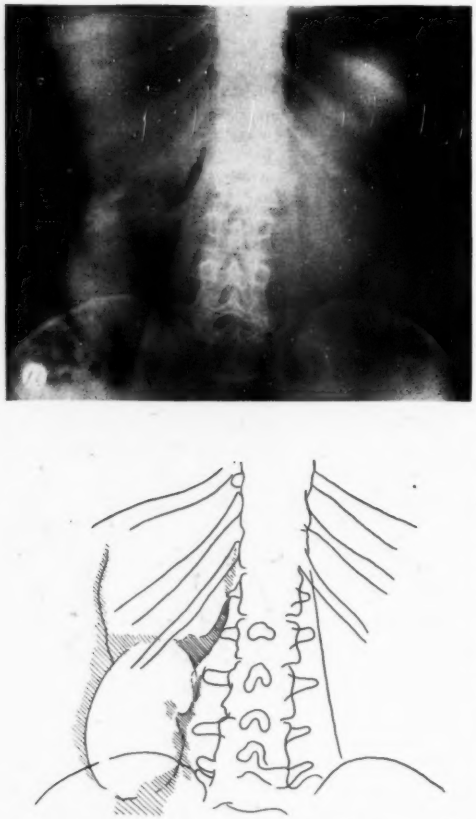


Fig. 2. Case 2. Air injection X-ray with tracing. The kidney is displaced by the mass above.

urine analysis by Kurzrok showed complete absence of ovarian hormone. She continued to feel well, and with a slowly falling pulse, she gradually improved. By the fourteenth day her wound had healed by primary union. Her blood urea was 13.3; creatinine, 1; uric acid, 1.80; sugar, 120; chlorides, 495; and carbon dioxide coefficient, 69.2. She was discharged on the thirty-seventh day following operation weighing 128 pounds, with a red blood corpuscle count of 5,000,000; white blood corpuscle count of 12,900—polymorphonuclear—80 per cent and blood pressure 140/96. She noticed that the hair was not growing again on her face and was thinning out on her body. She menstruated 61 days after operation for the first time in 2½ years. She complained of multiple arthritic pains all over her body. Her hair was distinctly less on her body. Her blood pressure was 130/80 and pulse 120. She menstruated again after an interval of 34 days for a period of 3 days. Her pubic hair outline was then horizontal. Her blood pressure was 116/74. She was taking atophan for the pains in her arms and legs. On September 9 she had slight jaundice. On the 16th she had palpable ovaries with tenderness in both fornices and had resumed marital relations with return of libido. She still had some hair on her face which had been treated by X-ray. She had been X-rayed on September 11, and her heart and aorta were shown to be normal with no evidence of metastasis. X-ray films of her entire osseous system showed no evidence suggestive of metastasis. She had a slight jaundice which subsided. Her icteric index changed from 75 to 52 in 1 week. In December she still complained of neuritic pains in both arms for which she was receiving treatment. By March she began to have headaches and hot flashes, and there was no lessening of the remaining hair on face or chest. She did not menstruate in March, which was the first period she missed since the resumption of menstruation in July.

In April there was a suspicious mass palpable in the epigastrium. X-rays of the chest showed scattered throughout both lung fields, small, indefinite shadows which were characteristic of metastatic tumor. She began to show the symptoms of previous illness. She felt full and bloated with a sensation of smothering. Her face again became red and flushed; her hair grew stronger and thicker and she gained in weight. In May she had a pulse of 92; temperature, 98; weight, 73 kilograms; height, 157.2; blood sugar, 1.72; basal metabolism, +33; hemoglobin, 87; red blood corpuscle count, 4,860,000; white blood corpuscle count 13,550—polymorphonuclear, 77 per cent; lymphocytes, 21 per cent; blood urea, 14.7; sugar, 105; icteric index, 15.9. In June complete X-ray examination showed small areas in the skull suggesting metastases. A rarefied area in the neck of the femur and multiple shadows throughout both lungs were also revealed. She had marked edema of both legs and shortness of breath. She was sent to the House of Calvary and expired in July, 1931. No autopsy was obtainable.

Microscopic examination of sections prepared from a number of different areas of the suprarenal tumor in this case shows: that the morphology of the neoplasm is maintained without essential changes in all its parts. It is enclosed in a well preserved capsule and is made up of many rather large masses of cells enclosed in a framework composed of slender fibrous strands bearing blood vessels. Exceedingly delicate branches, which can be demonstrated only with silver, pass from these and ramify between many of the cells. Many of these masses show evidences of cellular degeneration and liquefaction toward the center, leaving an irregular space which is either empty or contains granular débris and sometimes red blood cells. The tumor cells are of relatively uniform appearance although they vary somewhat in size. They are rather large, irregularly rounded or cylindrical with well defined cell membrane and voluminous, faintly acidophilic cytoplasm. In some areas the cytoplasm

is vacuolated as if it contained lipoid, although this could not be determined, as no material was available for fat stains. The nuclei in general are quite regular, eccentrically placed, rounded or ovoid, and with a single nucleolus, although some of the cells have two nuclei. Mitoses are present but vary greatly in relative numbers in different areas. Many cells seem connected with one another by slender cytoplasmic processes. With Laidlaw's silver reticulin stain, the cells are silver positive. This tumor shows no attempt at differentiation into the different layers of the suprarenal cortex.

Diagnosis: carcinoma of the suprarenal gland (cortical type).

CASE 3. (Chart 445624.) G.C., 16 year old student admitted to the hospital March 14, 1935, complaining of hair on face and body, a deep voice, and no menstruation. The patient's father and mother are alive and well. The father was born 39 years ago in Italy. The mother was born 33 years ago in the United States, of Italian parentage. Patient, the second oldest of the 4 children, has 3 sisters living and well. One brother died in childhood of an unknown cause. One sister died 2 years ago from a hip infection. There is no history of any family illnesses. The patient was born in the United States. She had measles and chicken pox in early childhood. At the age of 12 years she had mumps, and she had a positive Shick test. She began her schooling at 5½ years of age and is now in her third year in high school, which is normal for her age. She is considered bright, receives good marks, and is considered talented in music. She began to menstruate at the age of 13 and had 2 periods a month apart. Her hair then was brown, her form and voice girlish. After the second period, her hair became thicker and thick dark hair developed on her face, chest, arms, body and legs. This has gradually grown thicker and heavier. She has not menstruated since the beginning of this hairy growth. Her voice has changed; has become cracked and deep, and resembles a boy's "bass." She developed pimples on her face, chest, and back. She has not grown in stature or height since the change in her hair. She has had no headaches and no disturbances of her eyes except myopia.

The patient states that she is very good in athletics and is strong as a boy, although she is slight. She has no change in her affections and is sensitive concerning her present condition and wishes to be like other girls as soon as possible. She shaves her face daily.

Examination reveals a small, wiry girl with a very heavy black, bushy mop of hair, a "deep blue" partially grown moustache and beard, even though shaven. She had hair on chest, arms, and abdomen. Her thighs, legs, pubis, and genitalia were excessively hairy. The genitalia were practically hidden in a bush. Her labia were hypertrophied. She had a long clitoris almost 2 inches in length that stood erect like a penis. The urine was negative for albumin, sugar and pathological sediment. The

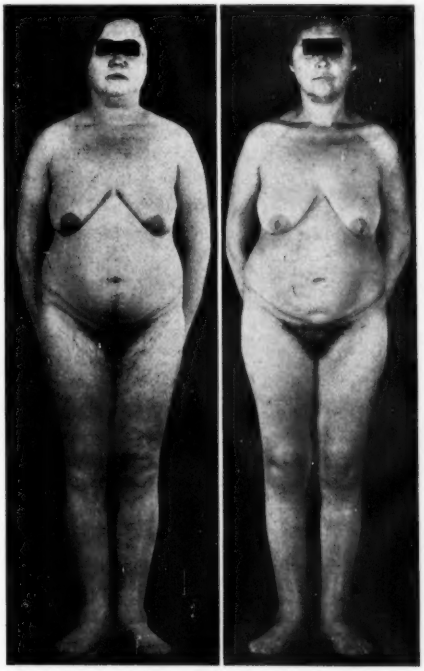


Fig. 3. Case 2. Before operation and 2 months after operation, showing change in pubic hair distribution and loss of acne.

red blood cell count was 4,900,000; hemoglobin, 90 per cent; white blood count, 11,480 with polymorphonuclears, 73; lymphocytes, 23; eosinophilia, 3; transitionals, 1. The blood urea was 16.1; blood sugar, 105; blood pressure 138/76.

On March 18, 1935, her blood showed: carbon dioxide content, 70.1; Cl (as NaCl), 5.9 grams per liter; inorganic products, 3.2; protein, 7.6; sodium, 141.5 milligrams per liter; potassium, 4.7; calcium, 10.2; non-protein nitrogen, 27. The pulse was 68; temperature, 97.4 degrees; weight 47.3; height, 152; body surface, 1.41; basal metabolism —8.

On March 20, 1935, pulse was 72; temperature 97.4 degrees; weight 47.3; height, 152; body surface, 1.41; basal metabolism, +1.

Eye examination showed a myopia of right 20/100; left 20/70. Her eye grounds were normal as were her perimeter fields.

On March 21, 1935, pulse was 68; temperature, 97 degrees; weight, 47; height, 152; body surface, 1.41; basal metabolism, —5.

X-ray films taken of her chest were normal; of her abdomen showed the left kidney low, as if pushed down. Her right kidney was normal. Cystoscopy showed a normal bladder and normally functioning kidneys. Pyelograms showed kidneys to all appear-

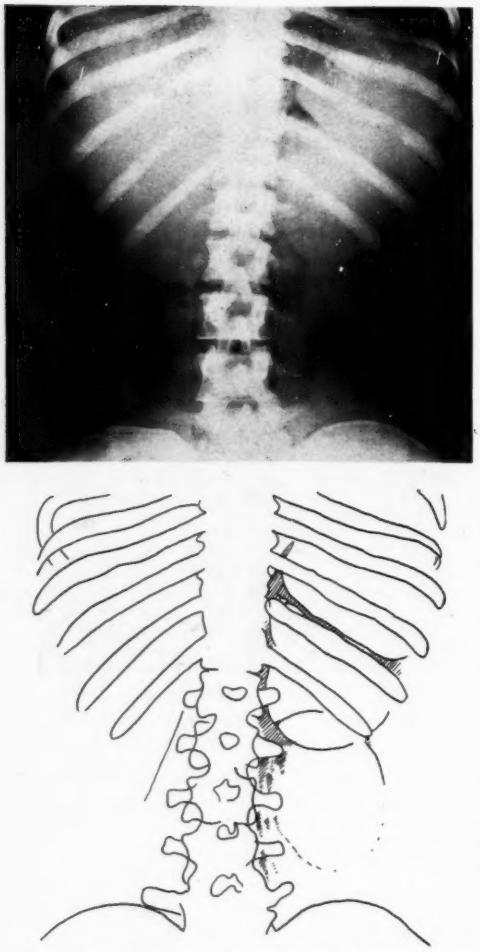


Fig. 4. Case 3. Air injection X-ray with tracing. Shows the air around the left tumor above the displaced kidney.

ances normal with the left low but not rotated. Roentgenograms taken after the injection of 250 cubic centimeters of air into the region of the left kidney showed a large tumor mass above the left kidney, rounded in shape and with a slight notch at the upper pole, and pushing the kidney downward. X-ray film taken after injection of 250 cubic centimeters of air into the region of the right kidney showed what appeared to be a normal right kidney and an apparently normal adrenal. X-ray film of the sella turcica appeared normal. X-ray film of the pelvis and extremities showed that the epiphyses had fused and no cartilage was present. Laryngoscopic examination revealed a male voice with the thyroid cartilage more prominent and with the vocal cords longer than in a girl.

April 9, 1935—sex hormone determination of urine showed: (1) Follicle-stimulating hormone, negative; (2) Follicular hormone 8 rat units per liter. (This is approximately normal for an adult woman.)

A glucose tolerance test was made March 15, 1935, and showed at 8 a.m. blood sugar, 95; at 8.30 a.m., 133; at 9 a.m., 133; at 10 a.m., 87; with the urine negative at all times.

The patient's bleeding time was 5½ minutes, and the coagulation time 4 minutes.

Chemical analysis of serum on 4-day excess salt diet showed: carbon dioxide content, 70.1; Cl (as NaCl), 5.9 grams per liter; inorganic products, 3.2; protein, 7.6; solium, 141.5; potassium, 4.7; calcium, 10.2; non-protein nitrogen, 27 milligrams.

Chemical analysis of serum on 4-day salt poor diet April 2, 1935 showed: carbon dioxide content, 70.8; Cl (as NaCl), 5.9; inorganic products, 3.5; protein, 7.4; sodium, 140.2; potassium, —; calcium, 10.2; non-protein nitrogen, 27 milligrams.

Pelvic examination showed the pelvis to be android with gynecoid characters and moderate sized outlet.

April 10, 1935, a left oblique subcostal transperitoneal incision was made and the abdomen was explored. The ovaries were very small. The uterus was small. The right adrenal area was palpated but no certainty was felt concerning its presence. There was a large round tumor mass above the left kidney and retroperitonal. Approach to this was made through the posterior parietal peritoneum, and the colon was displaced downward. The kidney and the tumor were exposed. The tumor was covered with large veins. These were ligated, as well as the adrenal artery, and the tumor was then delivered with its fascial planes, and removed. There was no injury to the adjacent structures and the tumor was handled very little. The posterior peritoneum was closed without drainage as was the incision in the anterior wall. Clysis of 2,500 cubic centimeters normal saline solution was given afterward.

April 11, the temperature was 103; pulse, 130; blood pressure 158/28. A clysis of 3,000 cubic centimeters normal saline solution was given.

April 12, the condition was excellent, she takes fluid well, her pulse is 100, and blood pressure 140/70.

April 14, temperature was normal; condition, splendid; blood pressure 120/60.

She made an excellent recovery and the wound healed by primary union. April 27, injection of air into the right side showed apparently no increase in size of the right adrenal as compared with the former X-ray films. She was discharged from the hospital. May 8, she began to menstruate, the first time in 3 years. It was quite profuse and lasted 4 days. Her voice has become more soprano. Her hair has been coming off her body when bathing. She menstruated the second time, at an interval of

29 days after the first period, which also lasted 4 days. She is very happy. The hair is less and she shaves now every fifth day. She menstruated the third time at an interval of 27 days after the preceding period. She was photographed for comparison. She is attending dances and enjoys her status.

Pathological report. (56596 Urol. No. 445624. J.C.) The specimen consists of paraffin blocks from The Squier Laboratory No. 2701. Microscopic examination of sections shows a very cellular tumor which appears to be partially encapsulated and which contains numerous areas of necrosis and some hemorrhage. The tumor cells are exceedingly numerous, rather oval or rounded, and somewhat loosely arranged in medullary masses with delicate strands of connective tissue running through them and dividing them into small nests, and occasionally in small, cord-like formations. In other areas the cells form rather broad sheets. The cells are fairly uniform in size, shape, and staining quality; have round or oval nuclei with a fine chromatin network, and show occasional nucleoli. The nuclei are located centrally within the cells. The cytoplasm is moderate in amount and rather deeply eosinophilic. No mitoses are seen. Small capillaries run between some of the nests of tumor cells. The larger blood vessels are also seen coursing through the tumor. Some of these blood vessels appear to be containing collections of tumor cells. In many areas the tumor resembles the adrenal cortex, particularly the reticular zone, and to only a slight extent the glomerular zone. Owing to the cellularity, the large areas of necrosis and the presence of tumor cells in blood vessels, I believe that this tumor should be considered a carcinoma in spite of the fact that no definite capsular invasions can be made out. Sections prepared with the trichrome stain (Fuchsinophil) show the cytoplasm of the tumor cells to be bright red. The iron, mucicarmine, Fontana, and phosphotungstic acid stains reveal nothing of note.

Diagnosis: carcinoma of suprarenal gland (cortical type).

CASE 4. (Chart 450269.) I.P., a married woman of Russian birth, 36 years of age, was admitted May 12, 1935, complaining of hair falling from her head and an excessive growth on her body. Her father and mother are alive and well. She has 5 brothers alive and well. One brother died in infancy. There is no history of family diseases. Patient had the usual children's diseases. Menses began at the age of 11 years and were regular every 28 days. She married at 22 and had two children, both difficult deliveries. One child is 11 years old, the other 9 years. About 6 years ago her menses began to be scanty and then ceased entirely. She noticed that about 3 years ago, her hair began to grow on her body and face. About 2 years ago, the hair on her head became thinner and she began to have hot flashes and frontal headaches. She has had no libido for the last 2 years. Her appetite is good; sleep is fair, and she is nervous and fearful. She shaves frequently.

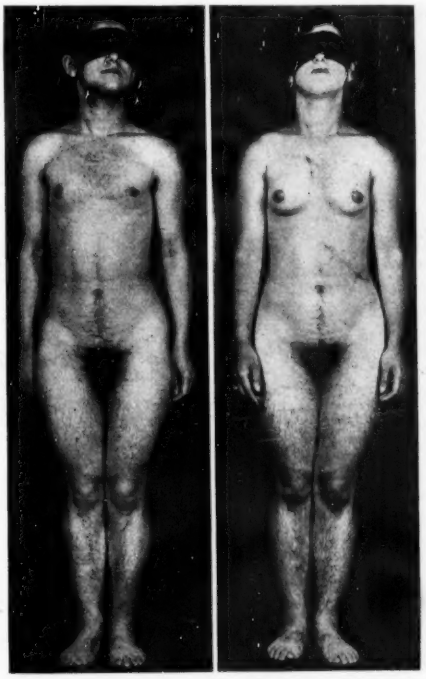


Fig. 5. Case 3. Before operation and 2½ months after operation. Shows a change in body contour, breasts, and hair distribution.

On examination she was found to be a well nourished woman, rational and voluble. The hair on her head was thin but bobbed. There was hair on her face but she shaves every few days. There was a moderate growth of long hair all over her body but especially around her genitals. Her pubic hair distribution was masculine. Examination showed marked relaxation of the anterior and posterior vaginal walls and there was a markedly lacerated and hypertrophied cervix. The clitoris was very large and resembled a small penis. There was some hypertrophy of the labia with deepening of color. Her voided urine was normal.

May 14, 1935, the patient's temperature was 98; pulse, 84; weight, 63.3 kilograms; height, 152.2 centimeters; body surface 160, basal metabolism −5. Her blood urea was 22.4, sugar 105 and carbon dioxide coefficient, 56. Her red blood count was 4,630,000; hemoglobin, 87 per cent, the white blood corpuscle count was 7,200 with polymorphonuclears 50 per cent, lymphocytes 37 per cent, eosinophils 8, miscellaneous 5. Cystoscopy revealed a normal bladder and normal renal function. X-ray examination of her chest was negative; of the skull showed a normal

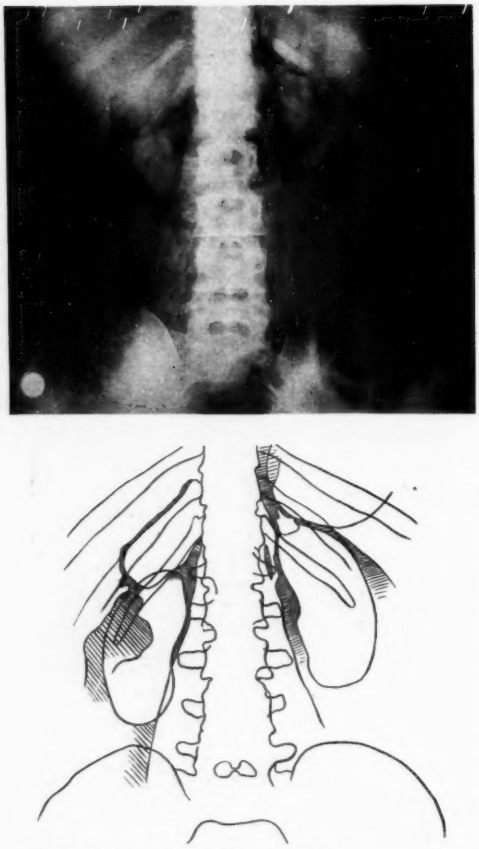


Fig. 6. Case 4. Air injection X-ray shows a tumor above the right kidney and a very small adrenal shadow on the left side. Died of adrenal cortical failure following removal of right adrenal tumor.

sella turcica; of the abdomen a low right kidney. Pyelographic X-ray showed normal kidneys. X-ray films after air injection revealed a rounded tumor of the right adrenal with apparently a small adrenal on the left side.

Operation was performed May 27, 1935. An oblique, right abdominal incision was made and the abdomen was explored. The ovaries were very small and hard; the uterus felt normal. The area of the left adrenal apparently had a mass, shaped and palpable as an adrenal. The peritoneum was opened to the right of the duodenum, and the right kidney and adrenal tumor were exposed. The vessels were ligated and divided and the right adrenal and its fascia removed, including the fascia anterior to the renal vein. The peritoneum was closed, and also the wound, without drainage.

Her condition was excellent following the operation. She was given 3,000 cubic centimeters normal saline subcutaneously. After 24 hours, her pulse became rapid and the blood pressure fell to 55/40. She was given a transfusion of 500 cubic centimeters of whole blood and a slow infusion of 2,000 cubic centimeters of 1 per cent saline. Eschatin in a quantity of 2 cubic centimeters was administered every 2 hours. Her blood pressure rose to 60/40 but after 4 hours, fell to 50/40. She was given another transfusion of 500 cubic centimeters of whole blood and 4 cubic centimeters of eschatin, with a continuous infusion of normal saline. She had difficulty in breathing; her blood pressure registered at 50, and with a convulsive attack, she died 32 hours after operation. No autopsy was permitted.

Pathological report, (No. 58597 Urological 450269, I.P.). The specimen consists of paraffin blocks from the Squier Urological Laboratory, No. 2766. Microscopic sections show a very cellular tumor which does not appear to be well encapsulated except along the margin of one portion, where several nests of cells are seen in a thick capsule which resemble cells from the glomerular zone of the adrenal cortex, and do not appear to be part of the tumor. The majority of the tumor is composed of large sheets of cells and smaller nests and cords of cells interspersed with delicate strands of connective tissue. The tumor cells for the most part are rather large and have pale, vesicular nuclei and indistinct nucleoli. These nuclei are usually centrally placed and show no definite mitosis. The cytoplasm of the cells is abundant, rather granular, pale pink, and in some places appears slightly vacuolated. In other places it is slightly foamy. The cells vary considerably in size and shape, but to a lesser degree in staining quality. Several areas of necrosis and hemorrhage are seen throughout the tumor. The tumor is interspersed with larger bands of somewhat hyalinized connective tissue which separates large masses from one another. These are infiltrated with tumor cells in many instances. There are numerous small and large thin walled blood vessels running through the tumor, and, in some areas, tumor cells appear to line vascular spaces directly. No tumor cells are seen within the blood vessel lumens. There is some fat adjacent to the tumor which shows slight infiltration by tumor cells. The trichrome stain (Fuchsinophil) shows that the cytoplasm of the tumor cells contain numerous red granules. The iron stain shows scattered deposits of hemosiderin in the heavier supportive stroma. The Fontana and phosphotungstic acid stain discloses nothing remarkable. The Laidlaw silver stain shows the tumor cells to be silver positive. This tumor resembles the adrenal cortex in many places and chiefly the reticular zone of the cortex, rather than the glomerular zone. Owing to its cellularity, lack of good encapsulation, invasion and necrosis, I believe this tumor must be considered malignant.

Diagnosis: carcinoma of suprarenal gland (cortical type).

Chart Number 16156. The following case was taken from the autopsy records of Presbyterian Hospital.

CASE 5. P.J.R., a male, aged 58 years, was admitted November 3, 1915, complaining of shortness of breath for 1 year. Family history was essentially negative except that one sister died following an operation for abdominal tumor. Patient had been well until 1 year before admission when he developed an increasing shortness of breath and a cough. The cough has increased with the production of a thick sputum occasionally streaked with blood. There had been a progressive loss of strength and weight. There had been no change in his hair.

On examination he showed evidence of consolidation of his right chest with flatness in the lower part. The liver edge extended 7 centimeters below the costal flare. He had a leucocytosis. The prostate was enlarged. X-ray examination showed the chest to be filled with metastatic tumor. X-ray of the skull showed metastasis in the right parietal region. Aspiration of the chest showed on microscopic examination, tumor cells, epithelial cells in character but not diagnostic.

On autopsy, he showed a cortical tumor of his right adrenal with metastases to pericardium, endocardium, lungs, liver, kidneys, and retroperitoneal tissues.

The following case presented the evidence of pubertas præcox with hirsutism, but without demonstrable evidence of adrenal change by X-ray. There was no operative interference.

CASE 6. L.S. (Chart No. 379627), a boy aged 11 years was admitted to the hospital May 29, 1933, complaining of dwarfism, excessive hairiness and sexual maturity. Father and mother were alive and well. There was no history of family abnormalities. Patient was the first born to his mother and considered normal up to 22 months of age. At that time he began to show evidence of structural changes. He began to become hairy at the age of 5 years, and at 7 or 8 years developed adult genitalia. He was backward at school; was apt to be moody and although at times was good-natured, he was likely to be sensitive about his condition. He was proud of his strength and adult characteristics, and was fond of cigars. No sexual history could be obtained from him as he refused to answer all questions.

On examination he resembled a muscular achondroplastic dwarf with profuse growth of hair on the face, chest, shoulders, arms, back and abdomen and legs. His genitalia were adult. Red blood corpuscle count was 4,880,000; hemoglobin, 92 per cent; white blood corpuscle count was 11,500 with polymorpho nuclears 80 per cent, lymphocytes 16 per cent, miscellaneous 4, and basal metabolism plus 10. There was no hypertension. X-ray examinations of his skull showed no change from normal. Repeated Wassermann tests were negative.

Fig. 7. Case 4. Before operation, showing the hair distribution.

Urine hormone findings by Kurzrok

Date	Prolan	Theelin
May 30, 1933	Negative	Negative
May 31, 1933	Negative	4 rat units per liter
June 1, 1933	Negative	4 rat units per liter
June 2, 1933	Negative	4 rat units per liter
June 3, 1933	Negative	4 rat units per liter
June 4, 1933	Negative	4 rat units per liter
June 5, 1933	Negative	2 rat units per liter
June 6, 1933	Negative	No rat units per liter
June 8, 1933	Negative	4 rat units per liter

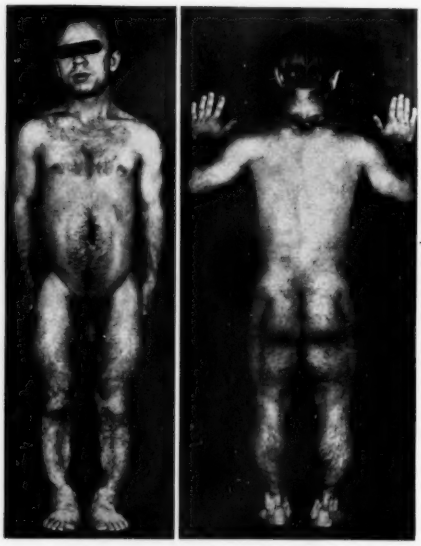


Fig. 8. Case 6. A boy of 11 years of age. Shows extreme hirsutism and precocious masculinity.

Analysis of his blood serum, fasting, was: Protein, 7.1; carbon dioxide, 68.2; sugar, .90 grams per liter; chlorides (as NaCl), 5.79; non-protein nitrogens, 25.0 milligrams per liter; phosphorus, 3.4; sodium, 136.2 mill-equivalents per liter; potassium, 4.8.

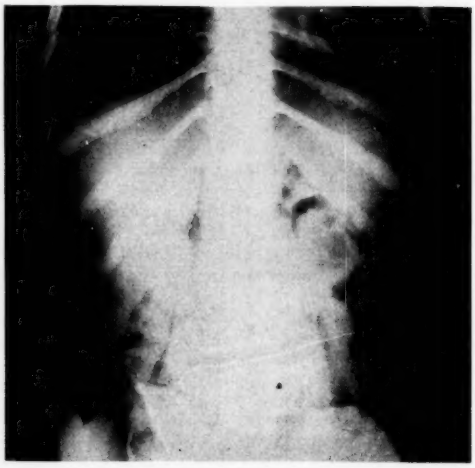
X-ray examination of the chest showed no evidence of thymus. Air injections of the adrenals showed the left adrenal to be larger than the right but of normal shape, and not sufficiently changed so that a diagnosis of tumor could be made.

The patient was taken home by his mother and no further study was possible in this case.

The following case was one in which the diagnosis rested between a basophilic adenoma of the pituitary, and bilateral hyperplasia of the adrenals.

CASE 7. (Chart 329378.) P.S., a girl 20 years old, was admitted to the hospital, complaining of obesity and irregular menses. Father, born in Italy, was a normal but illiterate laborer. Mother was born in Italy. There were 6 children. The eldest, a female, 22 years of age, finished 7th grade in school, the second was the patient; the third, a boy 17, reached 7th grade in school; the fourth a boy 14 was mentally deficient; the fifth child was 12 years of age and normal, and the sixth child died in infancy.

Patient was of normal birth and had had a normal childhood until 12½ years of age when menses began. She began to increase in weight. Her menses were regular for 5 months and then ceased.



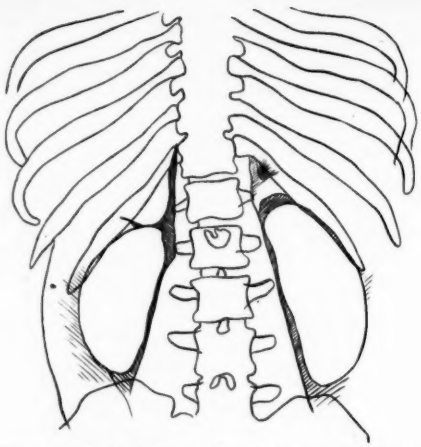


Fig. 9. Case 6. Air injection X-ray with tracing. No definite evidence of adrenal tumor. A suspicious change on right side. This case was not proven to be a tumor.

They did not recur until 2 years later. She developed a tired and sleepy feeling. She has had headaches over the eyes and in the occipital region for the last few years. There occurred a heavy growth of hair on head, eyebrows, and some on her face and chin and on her arms and legs. She suffered from chilly feelings and had fainting spells.

She weighed 301 pounds and was 65 inches in height. She had a heavy growth of hair on her head, some on the cheeks, upper lip and chin. There was marked hair on her arms and legs. The pubic hair distribution was masculine. Her breasts were medium sized and her abdomen was pendulous. Wassermann tests were negative. Blood urea was

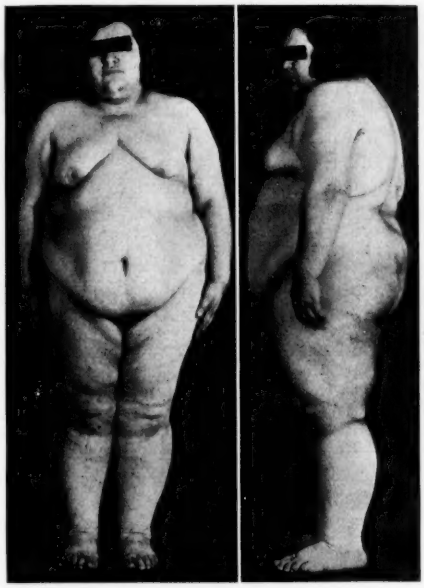


Fig. 10. Case 7. Shows obesity and hirsutism.

12 milligrams per liter and blood sugar was .97. Basal metabolism rate was plus 22. X-ray film of the skull showed no change in the sella turcica. Examination of her eye grounds was negative. Psychological determination classed her a "borderline defective." Her blood pressure was 170/30, pulse averaged 90.

On February 4, 1933, examination revealed 3 rat units per liter of ovarian follicular hormone in the urine. On June 8, 1933, examination revealed 9 rat units per liter of ovarian follicular hormone in the urine. Air injected on May 5, 1933, showed both adrenals were remarkably enlarged but apparently of the symmetry of a normal adrenal. Patient menstruated for 6 days while in the hospital, receiving 10 cubic centimeters of antuitrin during the week. She showed spreading of her teeth suggestive of acromegaly. There was no change from normal in the clitoris, labia, or pelvis.

No diagnosis was made but it rested between: (1) basophilic adenoma of the pituitary, and (2) bilateral hyperplasia of the adrenals.

CASE 8. (Chart 451144.) B.W., a girl, 23 years old, was admitted May 7, 1935, complaining of hair on her chest. Family history was negative except for 1 sister who has excessive hair on her body similar to the patient. This girl is 15 years old. Patient had had an apparently normal childhood except for empyema. Her menses began at 12 years and are of the 28 (5 to 7) day type. The flow is normal, with no disturbances up to the last period which she

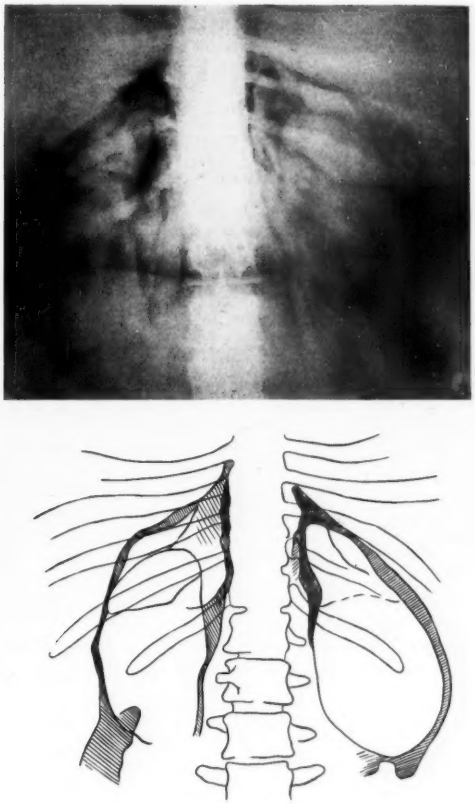


Fig. 11. Case 7. Air injection X-ray with tracing. There is apparently a hyperplasia of both adrenals.

missed without any known cause. Since she was 13 years old, she has had a gradually increasing black hairiness of the chest, arms and legs, and also of her face.

Examination showed a well nourished body. She was bright. She had long black hair on lips, chin, chest, abdomen, legs, and arms. The pubic hair was thick and masculine in character. There was no change from normal in the clitoris, labia, or vestibule. She had no hypertension. Her blood examinations were normal. Cystoscopy was essentially negative. X-ray of the skull was normal. X-ray of the chest showed evidence of an old empyema with operation on the right side. Air injected into her perirenal spaces did not reveal any change in the adrenals suggestive of hypertrophy or tumor. A pelvic examination did not reveal any demonstrable change in her uterus or ovaries from the normal.

CASE 9. (Chart 452126.) L.Z., a Jewish girl 21 years old, was admitted May 27, 1935, complaining

of nervousness and abnormal hair distribution, for 1 year. Family history was negative. Patient had had a fairly normal childhood. Her menses began at 14 years but have never been regular. They are now very scanty and she misses several months at a time. She has lost weight in the last few months. She has been very unstable emotionally. She has had to shave the hair that appeared on her face and arms. On the thighs and legs the hair is long and black. The hair on her abdomen, pubis and genitalia is thick and masculine in distribution. She has no hair on her chest.

Examination reveals normal pelvic organs, with no change in the clitoris or labia. There was slight hypertension: 140/80. Her blood count showed red blood corpuscles, 5,300,000; hemoglobin, 95 per cent; white blood corpuscles, 11,800, with polymorphonuclears 87 per cent. Her basal metabolism was minus 7. Wassermann tests were negative. X-ray films of her skull and chest were negative. Her blood chemistry examinations were essentially normal. Her urine on examination by Dr. Kurzrok showed: (1) 8 rat units follicular hormone per liter, (2) follicle-stimulating hormone not present. Air injected around both adrenals did not show any change in the adrenals that would warrant a diagnosis of hyperplasia or tumor.

The following case presented the symptoms of hirsutism and more or less disturbance of menstruation but no demonstration of adrenal tumor and no operative interference.

CASE 10. (Chart 448506.) B.A.G., a married woman 30 years old, was admitted on March 31, 1935, complaining of pain in the right flank with dysuria and frequency. She also had dyspnea on exertion, increase in weight and in growth of hair on her body, face, arms, and legs. Her family history was negative. Patient had had a normal childhood. She began to menstruate at 12 years of age. Periods increased in amount up to her marriage at 20 years of age. She has 1 child, 4 years old. For the last year, her menses have increased, lasting 11 days or so, and for a period of 3 to 4 months, it appeared daily. During this time the hair appeared on her face, arms, abdomen, and legs. She shaved her face and abdomen to make them appear feminine.

Examination revealed a stout young woman with pendulous breasts. She had hair on lip and chin, a male distribution of pubic hair, and increased hair on arms and legs. There was no hypertension. Pelvic examination showed hypertrophy of labia and clitoris with no palpable masses in the fornices or change in the uterus. Her blood count and blood chemistry were normal. Her urine showed pus, and cystoscopy with pyelographic studies revealed a colon bacillus cystitis. X-ray films of her chest and skull were negative. Air injected around both adrenals did not show any change that would warrant a diagnosis of increase in size or of tumor of the adrenal.

OBSERVATIONS

Hypertension occurs in many cases. This has been reported in the continuous type and is usually associated with a more rapid heart beat than normal. In our Case 2, the pulse rate was consistently over 120 beats per minute. The blood pressure was between 160/110 and 195/105. The high systolic readings in the 4 patients operated upon in order were: 155, 195, 138 and 150. From cases in the literature, the systolic reading varies in a wide range, rising rapidly with exercise and falling rapidly with rest. The hypertension of tumors of the adrenal medulla manifests itself more frequently in the paroxysmal type, associated with palpitation, weakness, dyspnea, and fainting during the attack, and with symptoms of pulmonary edema, and frequent death. A most interesting case of paroxysmal hypertension has been reported by Porter and Porter, in which an adrenal tumor successfully removed was pathologically reported by Ewing as cortical tumor of the adrenal. Why this should have produced these symptoms is not clear.

Of interest has been the association of the redness and duskiness of the face and hands with polycythemia. A case reported by Hunter, McMillan, Boyd and Cameron, had a red blood count of 5,570,000 and a hemoglobin of 109 per cent. A case of Khavine had a red blood count of 5,500,000. The case of Kayser and Walters had a red blood count of 5,290,000 and a hemoglobin of 80 per cent. Zucker reported a case with a red blood count of 10,500,000. Only one of our patients (Case 2), showed the redness and duskiness, and it was the only case with polycythemia. Her red blood count was 5,700,000, and her hemoglobin was 124 per cent by the Sahli method. The blood counts of the other cases with definite tumors, showed no change from normal.

The blood count in the cases of virilism but without proved tumors showed no change from normal except in the case in which the diagnosis rested between adrenal hyperplasia and basophilic adenoma of the pituitary (Case 7), and in this case the red blood count was 5,300,000 and the hemoglobin was 95 per cent.

Basal metabolism tests showed results which probably had a bearing only on the general endocrine state and not specifically on the adrenal situation. The reports showed:

Case 1, not done.
Case 2, +31 (case of obesity and low sugar tolerance).
Case 3, +1.
Case 4, — 5.
Case 7, — 7 (case of pituitary-adrenal uncertain diagnosis).

The chemical analyses of the various bloods showed no change from normal, or with some change from known causes not apparently related to the adrenal dysfunction. Only 1 patient showed low sugar tolerance (Case 2). Studies of the blood in these cases by Loeb, showed no abnormalities from normal in chlorides, inorganic phosphorus, sodium, potassium, or calcium.

Studies in the sodium chloride balance revealed no change from normal. There was no evidence that these cases had the opposite of the low balance seen in Addison's disease.

In 1 patient (Case 3) an air injection X-ray picture of the remaining adrenal, 30 days after successful removal of the tumor, showed an apparently definite increase in size of the shadow of the remaining adrenal (Fig. 20).

The report of Dr. J. J. Pfiffner who so kindly analyzed the tumor in Case 3, was quite interesting. He stated:

A fraction from the tissues was prepared and assayed on the adrenalectomized dog for the cortical hormone (life maintenance factor). I was unable to demonstrate the presence of the life maintenance hormone. The quantity of tissue available in work of this character is always a limiting factor. We can conclude from our data, however, that the concentration of the cortical hormone in this adenoma was less than 20 per cent of the concentration of the hormone in the normal beef adrenal cortex. No comparison can be made with the normal adrenal since no data on this point are available. It seems to me that these observations speak against the possibility of an excessive secretion of the cortical hormone (life maintenance factor) occurring in this case of virilism. In the course of separating the cortical hormone fraction from the adenoma, fractions were obtained which should have contained the sex hormones if they were present. These fractions were turned over to Dr. Kurzrok.

Three suggestions have been put forward by Collett for these sexual changes: (a) The adrenals act directly on the gonads. (b) The adrenal cells retain their primitive sex function and produce changes themselves. (c) The adrenal cells stimulate the anterior lobe of the pituitary which in turn acts on the gonads. He was of the opinion that suggestion (b) based upon investigations by Laulaine and confirmed by A. Kohn and Brachet, held the strongest consideration; and that the medullary and testicular part of the ovary are closely connected at an early stage with the suprarenal gland cortex, and should be involved with the suprarenal cortex during further development. When this change occurs in the suprarenal cortex, it is accompanied by secre-

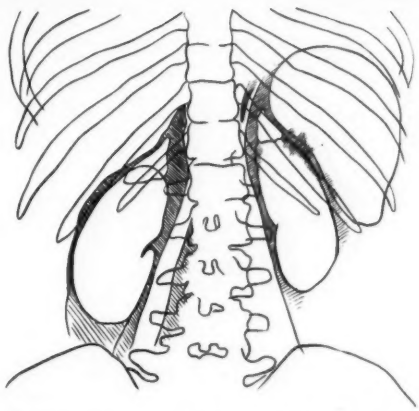


Fig. 12. Case 8. Air injection X-ray with tracing. There is apparently no evidence of adrenal tumor in this case of hirsutism.

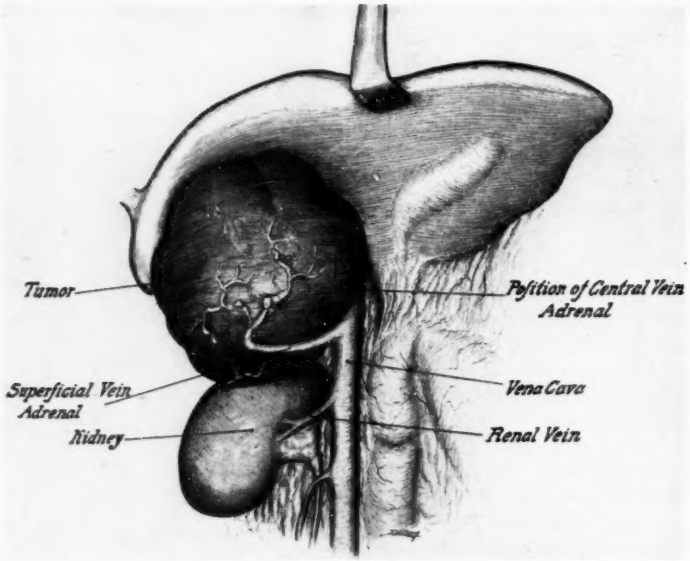


Fig. 13. Case 2. A drawing of right adrenal tumor showing venous channels.

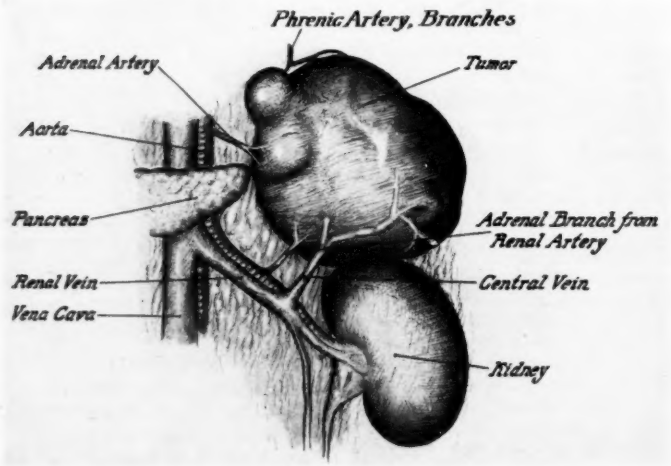


Fig. 14. Case 3. A drawing of left adrenal tumor showing the blood supply.

tion from these testicular cells; and through the testicular hormone, masculinization is produced. Examination of the ovaries in reported cases, however, apparently showed no change except atrophy.

The histology of these tumors showed a variation between the case without endocrine symptoms and those with endocrine symptoms. In Case 1, with no virilism, the tumor had a varied morphology, with an area of cords of epithelial cells reminiscent of all the layers of the adrenal cortex. The zona

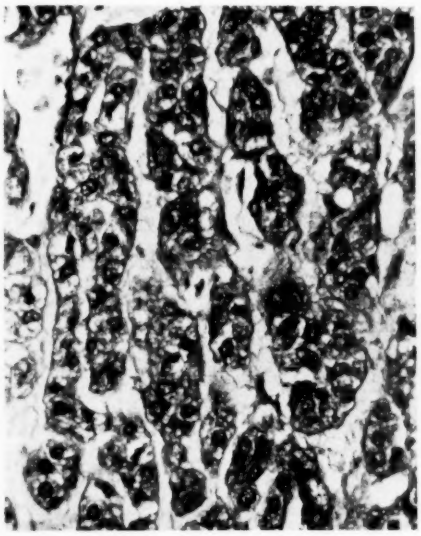


Fig. 15. Case 1. Photomicrograph of a portion of the tumor where the cells tend to form structures reminiscent of the zona fasciculata of the suprarenal cortex.

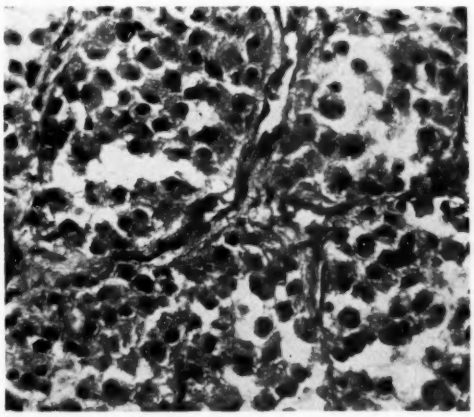


Fig. 16. Case 2. Photomicrograph of a representative area of tumor tissue showing masses of tumor cells with granular faintly acidophilic cytoplasm separated by delicate septa with capillaries.

fasciculata type of arrangement, perhaps, appeared in preponderance with fewer areas resembling the reticularis, and only occasionally, an area resembling the glomerulosa. In the remaining cases, all with virilism, the resemblance to the reticular zona was more apparent, with only a few areas resembling to a slight extent the glomerular zone.

This apparent variation of the cells of the tumors is of special interest in view of the work of Brostner and Vines, in which they found vivid red granules stained by fuchsin in the cytoplasm of adrenal cells in cases of virilism. Since the fuchsin granules were

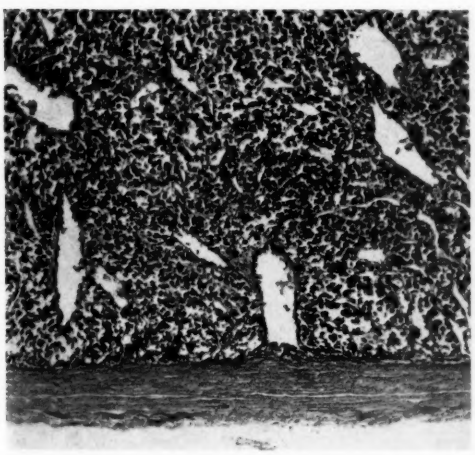


Fig. 17. Case 3. Photomicrograph of tumor near the capsule. Shows areas somewhat resembling the reticular layer of the adrenal.

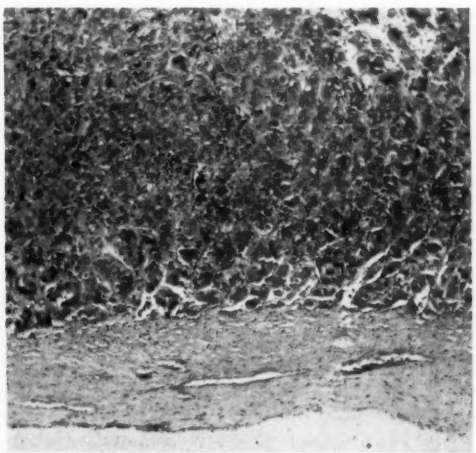
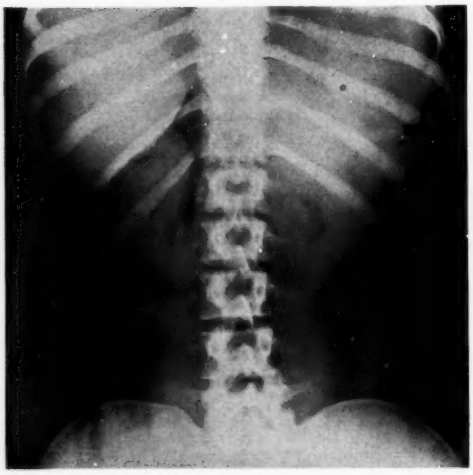
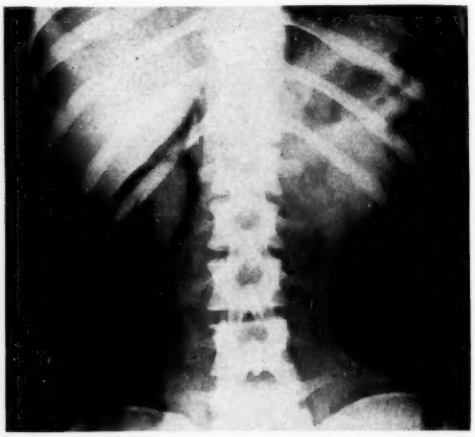


Fig. 18. Case 4. Photomicrograph of tumor near the capsule. Areas resembling the reticular layer are shown.





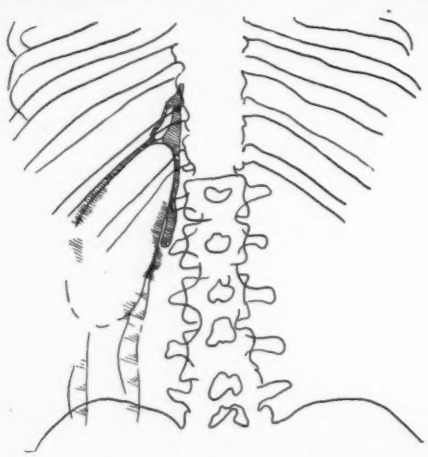


Fig. 19. Case 3. Air injection X-ray with tracing of the normal right adrenal before operation.

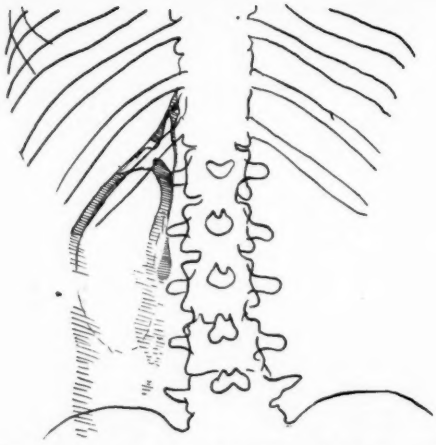


Fig. 20. Case 3. Air injection with tracing of the normal adrenal 1 month after operation. The adrenal shadow has apparently increased in size over the shadow in Figure 19.

found in the reticular layer of the adrenal, the assumption arose that the increase in cells and the increase in size of these adrenals was due to a change in the reticular layer. Goldzieher and Koster called attention to the importance of this observation and confirmed these findings. They stated that the microscopic examination of the adrenals in 5 cases of hirsutism and obesity without tumor showed the formation of an unusually broad, reticular layer of the cortex. This layer stood out not only for its abnormal width but also by the intense staining of the cell bodies with eosin.

Brostner and Vines collected from various sources material from 8 cases of cortical carcinoma and reported verification of the association of clinical virilism with fuchsinophil granules in the adrenal cells. They associate the presence of the fuchsinophil material with the masculinization of the female, although there is no proof that the material is the actual hormone which causes sex reversal. The fuchsinophil substance was

reported absent in growths which were not accompanied by sexual changes.

With the Masson trichrome stain which is identical in all details to the fuchsinophil stain described by Brostner and Vines, these tumors showed relative degree of this reaction (Table I):

TABLE I.

Case	Surgical Path.No.	Fuschsinophil reaction	Virilism
1	36423	1+	None
2	47864	4+	1+
3	58596	4+	1+
4	58597	3+	1+

For comparative controls to determine the amount of fuchsinophil granules and with estimations in relation to the amount of the tumor cells, we found: (1) Normal adult dog adrenal, ½ hour post mortem, 2+ reaction; (2) normal human adrenal, 3½ hour post mortem, 2+ reaction; (3)[1] normal human adrenal, 13½ hours post mortem, 3+ reaction; (4) normal human adrenal, 12 hours post-mortem, 2+ reaction; (5) normal human adrenal, 7 hours postmortem, 4+ reaction.

The dog adrenal showed most of the fuchsinophil reaction to be in the cells of the reticular zone of the cortex, less in the fascicular zone, and practically none in the glomerular zone. There were cells scattered throughout the reticular zone that took the reaction very strongly; but the majority of the cells took it only faintly. The nuclei were slightly darker than the majority of the cells in this zone with the trichrome stain, but when stained with hemotoxylineosin, no difference was made out. The human control adrenals showed this only to a very slight extent.

This study apparently did not show the striking contrast between the tumors and the normals as controls, as did the reports of Brostner and Vines. Definite increase in these granules was present, however, scattered throughout the tumor areas. The importance of these findings of the function of the reticular layer of the adrenal cortex and of the presence of the increase of the fuchsinophil granules with hirsutism is somewhat increased by the experiments of Miller, Deansley and Whitehead, who demonstrated an enlarged reticular layer of the adrenal cortex in the immature female rodent, and connected this "Zone X" with the influence of the adrenal cortex on the functions of the sex glands. Goldzieher considers the enlarged reticularis in the patients with obesity operated upon to be due to an exaggerated Zone X as regards both configuration and staining properties.

In all the tumor sections, the presence of lipoids was apparent. The Laidlaw silver stain showed that the tumor cells in all the cases were silver positive and did not form reticulin. The Fontana and phosphotungstic acid stains revealed nothing of note. In one patient (Case 4), the iron stain showed deposits of hemosiderin. There were no nerve fibers.

[1]This adrenal contained an adenoma in addition to the normal tissue. It was an incidental finding at autopsy in a case without any symptoms or signs of virilism.

CONCLUSIONS

1. Adrenal cortical tumors may occur without virilism.

2. Adrenal cortical tumors may occur with endocrine changes as follows: (a) pseudohermaphroditism (female); (b) premature puberty in the male; (c) growth maturity with masculinity in female children; (d) hirsutism, amenorrhea, and adiposity in adult females; (e) after menopause, an indistinct picture with adiposity; (f) possible inversion changes in male adults.

3. The adrenals may be adequately shown by the X-ray after air injections.

4. A possible diagnostic urine hormone is present.

5. Removal of adrenal tumors by the transperitoneal route is surgically better.

6. A percentage of cases of collapse following the removal of the adrenal.

7. As yet control of the collapse by cortical hormone is experimental.

8. Removal of the tumor produces a symptomatic cure of the endocrine symptoms but has no effect on the anatomical changes in the pseudohermaphrodite.

9. The metastases of these tumors produce the same endocrine changes as the original tumor.

10. The tumors that produce the endocrine changes have cells which resemble most the reticulate layer of the adrenal and have an increase in fuchsinophil granules over the normal.

11. Adrenal cortical hormone known as cortin has not been demonstrated in these tumors.

12. A sex or virilism hormone of these tumors has not yet been proved to be present.

I wish to express my gratitude to Dr. J. Bentley Squier, director of the clinic, for his guidance and helpfulness in this study. Thanks are given to Dr. J. J. Pfiffner for his careful work on the life maintenance factor; to Dr. W. C. von Glahn for his loan of materials and to the rest of the staff of the urological service for their material, their suggestions, and their cooperation.

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Discussion

Dr. H. Lisser, M.D., San Francisco: Dr. Cahill's presentation is timely. Recent years of illuminating research in experimental biochemical laboratories the world over have unfolded multitudinous discoveries of incretory functions and interglandular relationships, much of which engages the rapt attention of the endocrinologically minded clinician. A quickened interest has been aroused in "hormonal tumors," whose excessive or perhaps perverted production of this or that incretion, creates remarkable endocrine syndromes. As Cushing aptly phrased it many years ago in discussing hypophyseal disturbances, if it had not been for the factor of tumor "elbowing" itself into clinical prominence, our knowledge of the pituitary body might have been delayed far longer. And the surgeon, including the neurosurgeon, the urologist, and the gynecologist, has become aware of the great service he may render by

skillful removal of endocrine functioning tumors. One need but mention the spectacular relief from attacks of paroxysmal hypertension, by removal of an adrenal medullary paraganglioma; or the cessation of hypoglycemic fits of coma by enucleating a Langerhans island adenoma; or the restoration of calcium to the moth-eaten skeleton of an osteitis fibrosa cystica by similar excision of a hyperfunctioning parathyroid adenoma; or the transformation of a masculinized female into a refeminized woman by removal of an ovarian arrhenoblastoma.

The adrenal cortical tumors are equally fascinating in their production of bizarre endocrine manifestations: pseudohermaphroditisms, sexual precocity; sexual inversion; masculinization of the adult female as in virilisms and hirsutism, and feminization of the adult male with gynecomastia, etc. We are grateful therefore to Dr. Cahill and all others who record their clinical observations, for we need larger experience to aid us in earlier diagnosis and to improve our judgment of the wisest therapy. We must become more surgically minded toward these genito-suprarenal syndromes; not only in regard to tumors when indications for surgery are obvious, but also in cases in which quite similar symptoms and signs are due to hyperplasia. It must be increasingly realized that the size of a ductless gland is not necessarily an index to its function. The larger goiters are ordinarily associated with diminished thyroid activity. We are long since accustomed to practice subtotal thyroidectomy for hyperplastic hyperthyroidism even though the gland itself be enlarged only slightly. And until a now unpredictable method is evolved for combating overproduction of an internal secretion, we must resort to the cutting away of most of the overfunctioning tissue.

The most formidable difficulty encountered in pinning the diagnosis to adrenal cortical overactivity occurs in those cases, the great majority, in which no mass can be felt and in which retrograde pyelography also fails to reveal a tumor. I am especially impressed therefore with the aid Dr. Cahill has obtained by utilizing the injection of air into the perirenal fascia in order to visualize the adrenals by X-ray. This diagnostic maneuver would seem to be of the utmost importance not only in recognizing tumors too small to feel, yet not large enough to distort the pyelogram, but also in detecting hyperplasias, and in the case of large tumors, in obtaining some notion of the size at least of the supposedly normal adrenal.

However, if enlarged adrenals were found by this method, there would be some who would contest their responsibility for the syndrome, preferring to assume that the hyperplasia was secondary to the so called "pituitary basophilism," as claimed by Cushing. Such difference of opinion could be settled only by subtotal bilateral adrenalectomy; if the syndrome vanished thereby, it would be reasonable to consider the adrenals as the primary cause. After all they are simpler to explore than the hypophysis. I am interested in the transperitoneal approach; the technical merits of this as compared with the customary renal incision from behind is not one which the internist is qualified to discuss, but it would seem to possess one advantage—it might permit a view of or at least palpation of the pelvic organs and thus exclude an arrhenoblastoma.

The differentiation of adrenal cortical virilism (with amenorrhea, heterosexual hypertrichosis, perhaps obesity and hypertension) from Cushing's disease, arrhenoblastoma, and possibly, oat-cell thymus tumor, presents considerable difficulty if a tumor cannot be demonstrated as in the case of the pituitary, thymus and adrenal, by X-ray; as in the case of the ovary, by palpation. Whether hormonal studies of blood and urine will prove helpful remains a question for the future. At first thought it appears odd that a condition suppressing female functions should be associated with an excessive outpouring of female sex hormone in the urine. A paper (not by the writer) is to be published shortly, reporting excessive amounts of male hormone in virilism; a finding more in harmony with the clinical picture.

Whatever adrenal secretion is responsible for these extraordinary endocrinopathies, it is certainly not the medullary hormone, suprarenalin, nor the "indispensable to life" hormone, cortin. These sex abnormalities have not been reproduced experimentally by long continued overdosage with these substances.

It is to be hoped that some day we will be able to assay an individual's hormones quantitatively in blood or urine or elsewhere. To a limited extent this is possible even now. But when this can be done accurately for each hormone of each ductless gland, endocrine diagnosis and endocrine therapy will become vastly more precise and dependable. Meanwhile, however, we should familiarize ourselves with well established endocrine syndromes, for brilliant cures can be achieved even now.

SURGERY IN ITS RELATION TO HYPERTENSION[1]

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ESSENTIAL hypertension is characterized by an abnormally high blood pressure, which under excitement and physical strain frequently rises suddenly to high peaks. It develops most frequently in young people in the third and fourth decades of life, but it also may develop in the first, second, and fifth decades. Its progress may be slow, moderate, or rapid, terminating life at 10 to 15 years after onset, if its progress is slow; at 3 or 4 years, if moderate; and at 18 months, if rapid. Etiologically, essential hypertension is probably due to a fault in the neurogenic-endocrine vascular mechanism, since no other apparent etiological factors can be demonstrated. The vascular mechanism of individuals developing this disease appears to respond excessively to normal stimuli, an observation confirmed on examination of the blood pressures of children of parents with essential hypertension.

The appearance of low blood pressure in Addison's disease and the report of cures following the removal of isolated suprarenal tumor (20) with the sudden drop in blood pressure following administration of spinal anesthetic has aroused the imagination of the surgeons and encouraged them to attempt surgical procedures to decrease endocrine secretion or to paralyze the vasomotor control over large vascular areas by various forms of rhizotomy or sympathectomy (1, 2, 3, 5, 7, 8). We have employed a number of surgical procedures and herewith submit a report of these procedures and the results obtained. The interval following these operations is still too short to justify drawing definite conclusions, but the results which have been obtained to date suggest that surgical measures will probably come to play an important rôle in the treatment of essential hypertension. The inadequacy of medical treatment has further justified surgical investigation and attempts at surgical treatment.

ETIOLOGY

Physiologists have shown that endocrine secretions, particularly those of the suprarenal, pituitary, and thyroid glands, play important rôles in maintaining vascular tone. Though these secretions are important, it appears that the autonomic nervous system, particularly the sympathetic, plays an equally important rôle in the maintenance of vascular tone. The autonomic nervous system in normal individuals acts as a regulator or governor of the neurogenic-endocrine vascular mechanism. It stands in readiness to call out such reserves as the endocrine secretions, stored energy-giving substances, and it raises the blood pressure to facilitate the increased metabolism to meet the additional mental and physical demands. It alters the homeostasis and prepares the body for flight or fight (Cannon).

Excessive mental and physical demands may cause this regulating mechanism to break down, and, unless the condition is recognized early and steps are taken to reduce the strenuous activity of the individual, the disease will continue to progress. In other instances the disease does not seem to originate from excessive physical or mental demands, but appears to be the result of a faulty autonomic nervous system. At the onset the elevated systolic and diastolic blood pressures are of no particular significance, but as the continued load is carried by the cardiovascular mechanism, damage results, first in the peripheral arteries and then in the arteries and musculature of the heart. Symptoms, such as headache and precordial distress, together with those of chronic nephritis, retinal hemorrhages, papilledema, and cerebral hemorrhages, appear, in order, until death results.

Hypertension in later life, past 50 years of age, may slowly increase, with a corresponding development of arteriosclerosis. It should be borne in mind, however, that arteriosclerosis may just as often develop, and result in cardiovascular and cerebral degeneration, without the presence of hypertension.

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There are numerous other factors capable of producing increased blood pressures, but they should not be confused with the syndrome of essential hypertension, since in these instances definite pathological factors are responsible for the hypertension. For instance, the hypertension resulting from hyperthyroidism, suprarenal tumors, basophilism, and eclampsia may readily disappear and the pressures return to normal when the thyroid gland has been resected, the suprarenal tumor removed, the basophilism relieved by resection or by roentgen therapy of the pituitary gland, or when suprarenal hyperplastic tissue has been removed or the gravid uterus evacuated. Arteriovenous aneurism, stenosis of the aorta, and glomerular nephritis can also produce hypertension, but unfortunately the pathological factors cannot be relieved as easily as those produced by hyperthyroidism and suprarenal tumor.

SYMPTOMS AND CLASSIFICATIONS

Increased blood pressures may become well advanced before the patient is aware of an existing hypertension. Insurance examinations often are the first to disclose that such abnormal pressures exist. The development of symptoms follows a rather definite course. Hypertensive individuals are energetic, strenuous, and ambitious creatures who may not complain of any discomfort until headaches result from excessive mental exertion and fatigue. Accompanying this early symptom, the disposition of the individual may change, and he or she may become irritable and complain of insomnia. Precordial distress or a consciousness of cardiac action, with a sensation of tumultuous cardio-arterial action, soon follows the appearance of the headache. The continuation of these prodromal symptoms varies. Sometimes they appear fairly late in the disease and may remain more or less continuous, while again they occur intermittently and make their appearance during sudden, and but temporarily sustained, high blood pressures as long as the individual is subjected to the particular mental or physical strain which has initiated the paroxysmal attack.

Dr. Wagener, on observing the fundi of patients suffering from hypertension in its various stages of progress and with its varying degrees of blood pressure, has observed that the retinal arteries present correspondingly varying states of spasm; namely, less spasm and larger retinal arteries in the earlier stages, with slow progression of symptoms, and, in the later stages and in patients with a rapid progress of the disease, the reverse. We would naturally expect a destructive process, a sclerosing one, to follow the one of spasm. This suspicion has been corroborated by Wagener, inasmuch as certain branches of the retinal artery may vary in caliber due to spasm while others remain fixed apparently due to a sclerosing process. Retinal hemorrhages, flame-like in shape, occur fairly early in the course of the disease, but papilledema occurs only when the disease is well advanced or the progress is extremely rapid.

As the disease progresses, damage results in the cardiovascular mechanism similar to that which has been observed in the retinal arteries. Chronic nephritis develops; coronary sclerosis with accompanying myocardial changes, and coronary occlusion, may suddenly terminate the life of the individual. In some instances, cerebral symptoms, such as degeneration, with accompanying mental deterioration or vascular occlusion or rupture with the resulting monoplegias, hemiplegias, and epileptiform seizures, may occur. The arterial damage likewise affects the function of visceral organs and peripheral arteries of the extremities, but the compensatory factors appear to be more capable of adjusting the situation than are those controlling the circulation of the heart, kidneys, and the circulation of the retina and brain.

Numerous investigators (4) have attempted to classify patients into groups relative to the progress of the disease, but none has presented a more workable group than Keith (16), with the collaboration of Wagener and of Kernohan. Kernohan conducted pathological studies of arterioles in innumerable biopsies taken from the pectoral muscle of patients suffering from essential hypertension. He has definitely demonstrated hypertrophy of the media, and in some cases thickening of the intimal lining. Keith and Kernohan, and Keith, Barker and Kernohan, then collaborated in a study to learn if there existed a ratio between the

lumen of the arteriole and the thickness of the vascular wall. After analyzing 100 cases, they stated that there did exist a definite decrease in the lumen of the arterioles, in addition to a thickening of the walls, in comparison with specimens for biopsy from patients who were not suffering from hypertension. They found that in a normal small artery or arteriole, the ratio of the lumen to the width of the wall is about 2 to 1. This ratio decreases with the advance of the disease, and, in the rapidly progressing cases of essential hypertension, the ratio changed from the normal of 2 to 1, to 1 to 1, indicating that the lumen either has been reduced in size by the contracting process of the medial muscular layer, or that there actually has been hypertrophy of the media and intimal layers of the arterial walls. One can speculate concerning the factors responsible for such change, and we presume that it is fair to assume that the muscular hypertrophy of the medial coat is a compensatory change to provide for the additional strain on the smaller arteries of the vascular system from increased vascular tension. Criticism may be raised relative to the accuracy of readings of vascular studies on biopsy material; but so long as the control also was made on biopsy material, we believe that comparative reading is worthy of consideration and suggest that this thickening of the arterial wall is a definite finding associated with essential hypertension.

In grouping cases of hypertension according to the progress of the disease, Keith has called those with slow progression *benign* hypertension, those with moderate progression *early malignant* hypertension, and those with rapid progression *malignant* hypertension, since he hoped that these terms, benign, early malignant, and malignant, would indicate not only the rate of progress, but would also signify the character of the symptoms; for example, that "malignant" would not only signify that the disease was rapid in its progress, but that the symptoms were also very marked. This classification is slightly misleading since the patients with benign hypertension in the later stages will present as marked cardiovascular and renal symptoms as those suffering from malignant hypertension. However, in order to have a better understanding of the progressive nature of the disease, it is well to follow this classification until a better one has been developed.

We, therefore, find that Keith's *benign* group, those in which the disease develops *slowly*, includes individuals in whom the disease originates between the ages of 40 and 55 years and continues for a period of 10 to 15 years before it develops to such an extent as to terminate life. In the earlier stages of benign hypertension, intermittent headaches and the presence of retinal arterial spasm are the only symptoms and findings present other than that of elevated blood pressure.

Keith's second group, *early malignant* hypertension, which develops *moderately fast*, begins during that interval between the eighteenth and fiftieth years of life and progresses for a period of 3 to 4 years before death results. Retinal arterial spasm is associated with hemorrhages and evidence of retinitis. The blood pressure is capable of rises of 200 millimeters of mercury systolic and 160 millimeters diastolic. Irreparable cardiac, coronary, and renal injuries present symptoms in the later stages of the disease in this group.

Keith's third group, *malignant* hypertension, which progresses *rapidly*, may occur during the same years as in the early malignant group. However, the life expectancy after the onset of symptoms in this group is much shorter and averages only 18 months. Examination of the fundus reveals arterial spasm, arterial sclerosis, retinitis, hemorrhage, and edema. The symptoms of cardiovascular and renal disease progress rapidly. The systolic blood pressure frequently rises to 250 to 300 millimeters of mercury and the diastolic to 160 millimeters of mercury.

REVIEW OF SURGICAL PROCEDURES

On the basis of postmortem investigations and theoretical considerations, section of the splanchnic nerves was suggested by Jean, in 1921, for the relief of pyloric spasm, hyperacidity, and hypersecretion. In 1923 Daniélopolu, considering the importance of the splanchnic nerves in the regulation of arterial pressure, conceived the idea of their resection in the treatment of hypertension. In the same

year Bruening and Stahl also suggested the same surgical procedure, and in 1924 Pende proposed, before the Congress of Internal Medicine at Milan, surgical treatment of arterial hypertension which consisted of resecting the left splanchnic nerves. In 1927 Pieri (25) performed unilateral resection of the splanchnic nerves for intestinal atony. In 1930 Pieri (26), following the suggestion of Pende, successfully resected the left splanchnic nerves of 2 patients who were suffering from arterial hypertension. In 1932 Durante, of Genoa, resected the large and small left splanchnic nerves of 2 patients suffering from different arterial diseases. These cases were reported by Santucci, and although they were not true cases of hypertension, the postoperative observation indicated a fall in both systolic and diastolic pressures. In giving a résumé of the surgical techniques which have been described in the literature, Pereira stated that Pieri's technique consisted of resection of the splanchnic nerves by means of the supradiaphragmatic approach, after resection of the tenth, eleventh, and twelfth ribs. Rossi attacked the splanchnic nerves between the attachments of the diaphragm after resection of the transverse process of the eleventh and twelfth thoracic vertebræ and, when necessary, the twelfth rib. Pereira objected to the two previous techniques because of the danger of injuring the pleural sac, and he proposed section of the splanchnic nerves below the diaphragm without resection of bony structures.

Our interest in attacking essential hypertension surgically began in 1925, when one of us (Adson), at the suggestion of Rowntree, performed bilateral lumbar sympathetic ganglionectomy and trunk resection, which included the second, third, and fourth lumbar ganglions on both sides, in a case of malignant hypertension. There was some symptomatic relief, but the patient did not obtain a material drop in blood pressure and we doubt if this operation materially altered the progress of his disease. The failure to lower the blood pressure, we believe, was due chiefly to the fact that the operation was limited in scope and did not include enough postganglionic rami to produce definite vasomotor relaxation. During the same year, one of us (Adson) carried out unilateral cervicothoracic sympathetic ganglionectomy and trunk resection in a case in which a boy, 11 years old, had malignant hypertension. His blood pressure had been very high and there was resulting cardiovascular damage. Sympathectomy was performed for the purpose of determining whether or not it would produce vasodilatation of the retinal arteries as it does in cases of Raynaud's disease when spasm is responsible for the reduction in the caliber of the arteries. In this case the disease had definitely produced sclerosis of the retinal arteries, and, consequently, no relaxation or increase in the caliber of the retinal arteries took place. This discouraged us from proceeding with other operations on the sympathetic nervous system in this particular case, and it was not until 1930 that our interest was renewed by an experience one of us (Adson) had in which an attempt was made to relieve gastric crises due to syphilis by performing an extensive rhizotomy. Rhizotomy in this last case consisted of section of dorsal and ventral roots on both sides, from the sixth thoracic to the second lumbar segments, inclusive. The patient survived the operation, was able to get about, and was not materially inconvenienced by paralysis of the abdominal muscles, which condition was relieved by the aid of an abdominal supporter. The pain of gastric crises was definitely relieved but, unfortunately, the patient succumbed several months later from general paresis.

This experience, however, suggested the possibility that an extensive vasomotor paralysis might be accomplished by sectioning the anterior roots of both sides, from the sixth thoracic to the second lumbar, inclusive. This was carried out by one of us (Adson) with the aid of Dr. Craig. The drops in blood pressure following successive sections of the ventral roots in the area described were phenomenal. The systolic blood pressure dropped from 200 to 100 millimeters of mercury. The diastolic blood pressure dropped from 120 to 90 millimeters of mercury; but, unfortunately, postoperative hemorrhage developed though the clot was removed and a partial spastic paraplegia developed which persisted. These sequelæ prevented an immediate report of the

case, and discontinuance of the operative procedure until October 10, 1933, when a second patient with essential hypertension was operated on. At this time an extensive rhizotomy of the ventral roots on both sides, from the sixth thoracic to the second lumbar segments, was done. The revival of interest in the operation was prompted by two factors: (1) The blood pressures of the original patient did not return to the pre-operative levels and the patient continued to survive, the systolic blood pressure ranging from 140 to 160 millimeters of mercury and the diastolic from 80 to 110 millimeters; and (2) the results of splanchnic section obtained by one of us (Craig) did not appear to produce the results desired, which suggested the possibility that the splanchnic operation as performed by him was not extensive enough in scope and did not include as many vasomotor fibers as did ventral root rhizotomy.

One of us (Craig) has introduced an operation for essential hypertension which includes a section of the major and lesser splanchnic nerves below the diaphragm. In addition, the sympathetic trunk between the twelfth thoracic and first lumbar sympathetic ganglions was divided. This first operation was performed by Craig on October 26, 1932. The approach used to expose the structures to be sectioned was a straight line incision placed laterally to the lower thoracic and upper lumbar spines on the left side. After the skin and subareolar tissues were reflected, the latissimus dorsi and the quadratus lumborum muscles were incised. The approach gave excellent exposure of the splanchnic nerves but was inadequate to permit removal of the two upper sympathetic ganglia. However, in subsequent cases, Craig did include the first lumbar ganglion with section or resection of the splanchnic nerve. On April 1, 1933, Craig employed the supradiaphragmatic approach in 1 case for section of the major and lesser splanchnic nerves. He entered the mediastinum on the right side opposite the eleventh rib after having resected 4 centimeters of the rib adjacent to the transverse process in order to secure exposure of the splanchnic trunk. The pleura was rather thin, and it was opened during the operation. Consequently, he chose to employ the subdiaphragmatic technique previously referred to for his future resection of splanchnic nerves and removals of first lumbar ganglia.

Perhaps the same comment might be applied to these procedures as was applied to those used by Peet, and which justify the modification as proposed and carried out by one of us (Adson). This new approach is a subdiaphragmatic, intra-abdominal, retroperitoneal approach through a high kidney incision. It permits of ample room and exposure of the splanchnic nerves, first and second lumbar ganglia, and the suprarenal gland. It appears that the result is as effective a vasodilating procedure as extensive bilateral ventral rhizotomy.

Up to the present, October 1, 1935, 27 patients with essential hypertension, of varying degrees of severity and progress, have been submitted to extensive rhizotomy. Seven have had bilateral section of splanchnic nerves, including the major, minor, and lesser splanchnic nerves. Seven patients have been subjected to bilateral resection of splanchnic nerves with removal of the first and second lumbar sympathetic ganglia on both sides. Specimens for biopsy were taken from each suprarenal gland in 1 case, and resection of half the suprarenal gland on each side was performed in the 6 other cases. Four patients have been operated on for essential hypertension by miscellaneous procedures; namely, bilateral lumbar sympathectomy, left cervicothoracic sympathectomy, resection of the sixth to the twelfth intercostal nerves to produce paralysis of abdominal muscles, and complete removal of one suprarenal gland and removal of three-fifths of the opposite suprarenal gland, performed by Walters (19) and his associates.

Crile for a number of years has attempted to alter the cycle of endocrine secretions, chiefly those of the suprarenal gland, and has performed numerous denervations for a variety of cyclo-asthenia as well as for recurring hyperthyroidism, recurring duodenal ulcer, vasomotor disturbances, and hypertension. Denervation itself has apparently not controlled essential hypertension, but when combined with splanchnic section it has been

quite effective. The DeCourcys (11, 12) have followed the line of reasoning of certain physiological investigators who believe that the amounts of epinephrine secreted are the factors responsible in determining the course of hypertension. They have, therefore, advised and performed resections of the suprarenal glands, believing that it is necessary to resect from three-fourths to four-fifths of each gland in order to produce the desired drop in blood pressure, and that it is possible to resect such quantities of the suprarenal gland without producing glandular deficiencies and Addison's disease. Page and Heuer have reported a goodly series of cases of hypertension in which treatment has been by ventral root rhizotomy. Rhizotomy has varied from complete inclusion of roots from the sixth thoracic to the second lumbar, to partial rhizotomy, taking either the upper or lower half of the group described. Their results are not unlike ours, unless perhaps they are slightly better, which might be explained on the basis that they made better selections of cases for operation, whereas in the beginning we had to select our cases more or less by trial and error.

Peet recently reported, at the Surgical Section of the American Medical Association, a large series of cases in which he had sectioned the splanchnic nerves on each side. He entered the mediastinal cavity on each side of the spinal column after resecting a portion of the eleventh rib on each side. He then proceeded to section the major splanchnic nerves opposite the ninth thoracic vertebra and the lesser splanchnic nerves opposite the eleventh thoracic vertebra. His results are unusually good, and he attributes them to the fact that section of the splanchnic nerves above the diaphragm interrupts a few postganglionic rami which travel along the abdominal aorta to join the celiac plexus. Even though this is true, the white rami carrying vasomotor fibers, as well as fibers of suprarenal innervation, cannot be included in the operation as performed by him above the diaphragm. Furthermore, if this were true, the extensive rhizotomy which includes the ventral roots of the sixth thoracic to second lumbar vertebræ should be as effective, if not more so, since it interrupts all of the preganglionic thoracolumbar sympathetic fibers below the fifth thoracic segment. There is a possibility that section of postganglionic rami may be more effective in relieving vasomotor spasm than section of preganglionic fibers.

Extensive rhizotomy, whether performed in one or two stages, is a rather formidable procedure. It was for this reason that one of us (Adson) therefore proposed, and carried out first on February 11, 1935, a subdiaphragmatic exploration of the splanchnic nerves, the first and second lumbar ganglia, and the suprarenal gland. Through the right and left explorations, respectively, all of the splanchnic nerves as they enter the abdominal cavity, and the first and second lumbar sympathetic ganglia, can be resected, thus interrupting the white rami which carry efferent impulses to these ganglia and lumbar trunks to the celiac and renal sympathetic ganglia. One is also able to explore, to take specimens for biopsy, or to resect, the suprarenal gland.

Up to the present time 7 patients have been operated on by this procedure, without fatalities. Six of them have undergone operations on the right and left sides, respectively, on separate dates, with intervals of 10 days to 3 months between operations. The results of these various operations will be evaluated in another paragraph and so it is sufficient to say here that it appears that the results obtained from a combination of resection of splanchnic nerves and removal of the two upper lumbar sympathetic ganglions, in conjunction with resection of the suprarenal gland, is as effective as extensive rhizotomy, if not more so, since there is an opportunity to resect the suprarenal gland without producing trauma to the remaining portion.

BLOOD PRESSURE REACTIONS IN HYPERTENSION

The underlying and primary abnormality demonstrated in cases of essential hypertension has been an excessive response of the blood pressure to various forms of stimulation. This response is of the same order as that observed in non-hypertensive subjects, but it is excessive. The work of Hines and Brown on the hereditary factors indicates that this excessive reaction occurs early in life and follows the laws of heredity. The modern

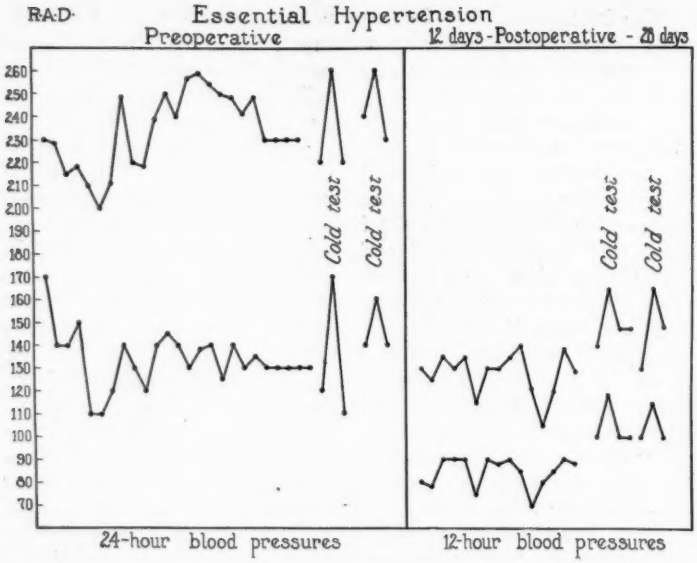

Fig. 1. Variations in systolic and diastolic blood pressures prior to rhizotomy. The two interrupted lines of the cold tests taken before rhizotomy illustrate the height that both the systolic and diastolic pressures may attain. The chart on the right represents similar readings taken following rhizotomy.

conception of essential hypertension is, then, that the individual inherits a hypersensitive vasomotor mechanism, as measured by the blood pressure. This excessive reaction may be a causal factor in the production of hypertonus and hypertrophy of the arterioles, which eventuates in increased levels of blood pressure and in what we recognize as the clinical stage of essential hypertension.

A simple method has been evolved to measure the reactibility of the blood pressure. This has been designated as the *cold pressor test* (Fig. 1) and consists of placing the patient's hand in ice water, at 4 degrees C., and taking the blood pressure. The basal blood pressure is obtained during rest; the hand is then placed in the ice water and in 30 seconds the blood pressure rises to what is known as the *ceiling*, or highest response. The blood pressure returns to normal in from 2 to 8 minutes. This pressor test then becomes a measure of the individual's response to a given stimulus. It is constant for the hypertensive or prehypertensive individual, and is three to ten times greater than that found in the normal or non-hypertensive subject. The application of this test is important in the evaluation of the effects of therapeutic procedures. Measures to control the blood pressure, to be effective, must control this variability factor. Surgical measures in which the vasomotor control of a large portion of the blood vessels is cut off from the central mechanism can be evaluated to an accurate degree by the change and reduction of the ceiling and vasomotor response to the cold pressor test. It becomes an effective measuring rod for therapeutic procedures. It obviates in some degree the difficulty encountered by attempting to evaluate therapeutic measures in hypertension by occasional readings of the blood pressure.

STUDIES ON THE EFFECT OF POSTURE ON BLOOD PRESSURE

The completeness of surgical procedures which denervate the splanchnic circulation can be measured with considerable accuracy by studying the effects of posture on blood pressure. The blood pressure normally changes to some degree with changes in pos-

ture. In persons suffering with the clinical syndrome known as postural or orthostatic hypotension (Fig. 2) there is a drop in the blood pressure, both systolic and diastolic, while the patient is in the upright position which is sufficient to produce syncope. Associated with these drops is, in addition, loss of sweating in certain areas of the body. Following extensive anterior rhizotomy, a fall in blood pressure develops which is comparable to that seen in postural hypotension. This is measured by placing the patient on a table which can be tilted at various angles. The blood pressure is taken with the patient in the horizontal position, then with the head down and the feet up, and then with the head up and the feet down. A drop of from 40 to 80 millimeters of mercury in the systolic blood pressure with an increase in the pulse rate has been observed with the patient in the upright position. A drop of this magnitude presents objective evidence of the loss of splanchnic control to maintain the blood pressure in the upright position. Lesser degrees of drop in blood pressure have been observed after the less extensive operations.

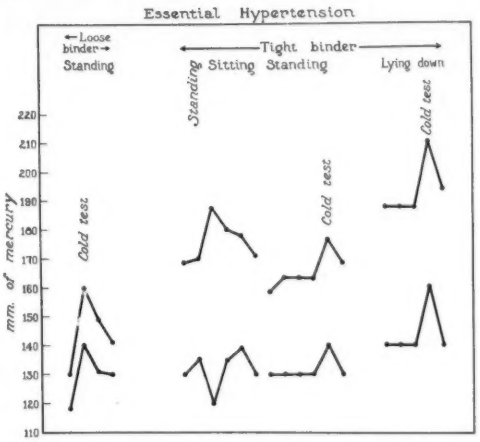

Fig. 2. Variations in blood pressure following rhizotomy, while patient is standing or lying down, and the reactions to the cold test with or without the abdominal binder. Rhizotomy produces a hypotension which can be regulated by the application of an abdominal support.

RENAL FUNCTION

Studies on renal function have shown that there is a definite change in the excretion of water with the various postures after section of anterior roots. In daytime, when the patient is in the upright position, there is a decrease in the excretion of water; during the night, with the patient in a recumbent position and when there is a higher blood pressure, there is an increased excretion of water and nocturnal polyuria. Page and Heuer in the report of a case have shown that urinary efficiency and the ability of the kidneys to concentrate was normal before this operation and remained unchanged afterward.

SURGICAL INDICATIONS AND SELECTION OF CASES

In attempting to select cases which will respond to rhizotomy or extensive sympathectomy, it is necessary to take into consideration: the character of the symptoms, the rate of progression of the disease, the response to medical measures, the effects of the "cold pressor test," the age of the patient, and the amount of cardiovascular and nephritic damage present. Our experience with patients submitted to the various types of sympathectomy and rhizotomy has taught us that the best results will be obtained when symptoms are still mild and when there is definite evidence of an unstable level of blood pressure, that is, when the least excitement or continued exertion results in systolic peaks of 200 millimeters or more and diastolic peaks of 140 to 160 millimeters.

Naturally one does not want to advocate surgical intervention in the treatment of this disease unless there has been definite evidence that one is dealing with essential hypertension. On the other hand, it is useless to advocate sympathectomy when the high levels have become sustained and when irreparable damage has resulted from the progress of the disease. We are quite convinced that, when medical measures fail and when the "cold pressor tests" reveal hyperactive responses, as observed in essential hypertension, surgery is indicated. Our experience also reveals that patients developing symptoms in the third and fourth decades of life respond most favorably to surgical intervention, and that those presenting the symptoms, as grouped by

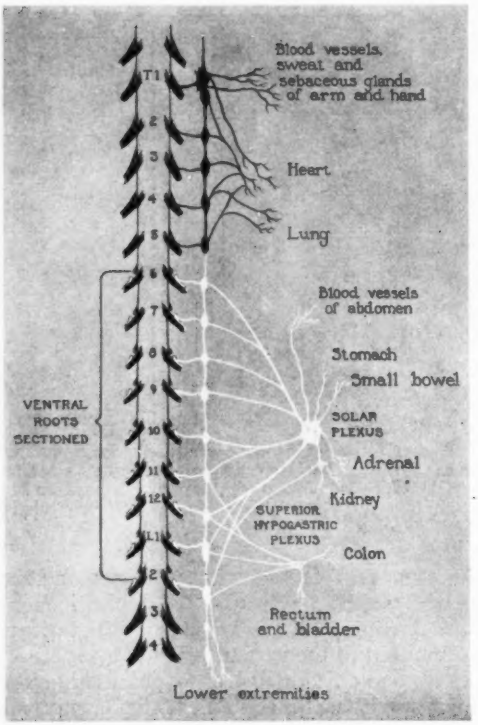

Fig. 3. Sympathetic nervous system affected by sectioning ventral roots for essential hypertension from sixth thoracic to the second lumbar segments on both sides. The sympathetic ganglions shaded dark represent those which receive efferent impulses, and those that are left light have been deprived of these impulses.

Keith in the benign hypertensive group and the early malignant hypertensive group, will obtain much more satisfactory results than will those who are grouped within the malignant group, since those in the first two groups will still have an elastic vascular system capable of being relaxed, whereas in the latter group there is more likely to have been permanent damage, with arteriosclerosis and fixation of the vascular walls. This latter group is unable to respond to vasodilating measures, and the condition invariably has resulted in irreparable damage to the vascular system, heart, and kidneys.

We are quite in accord with the practice of having every patient who submits himself or herself for examination for hypertension carefully analyzed and the status of the disease determined before active surgical treatment is instituted. Although there is no specific medication or diet for the treatment of this disease, a therapeutic test of the medical regimen is worth while to determine whether or not it is possible to decrease the blood pressure and to ameliorate the symptoms. The usual advice given consists in encouraging the patient to live less strenuously, to regulate hours of work, with daily midday rest periods of an hour, and to adjust his program in order to reduce the worry associated with economic or social existence. Avoidance of overweight, a change of vocation or an extended vacation—all are of definite value in attempting to reduce a strenuous existence. In the more extreme cases, continued rest in bed and the administration of such barbiturates as phenobarbital and sodium amytal may temporarily lower the blood pressure and reduce the intensity of the symptoms.

In an attempt to select suitable cases for operation in the beginning of this study, patients were subjected to spinal anesthesia for the purpose of determining if the drops in blood pressure could be affected by temporarily paralyzing the functions carried over the ventral roots below the fifth thoracic segment. Curiously enough, blood pressures dropped in all cases, regardless of the phase of the disease. Much of the drop may have been due to an extensive vasomotor paralysis, which included all the vessels below the diaphragm. There was also a possibility, however, that the spinal anesthetic produced part of this drop in blood pressure by inhibiting the central mechanism through the absorption of the anesthetic. The test of spinal anesthesia is, therefore, not as reliable as one would wish in the selection of suitable cases for operation.

SURGICAL TECHNIQUE

The two operative procedures which we have employed consist of: (1) extensive bilateral section of ventral roots of the lower thoracic and upper lumbar roots, and (2) extensive subdiaphragmatic sympathectomy, which includes the splanchnic nerves on each side as well as the two upper lumbar ganglia, and

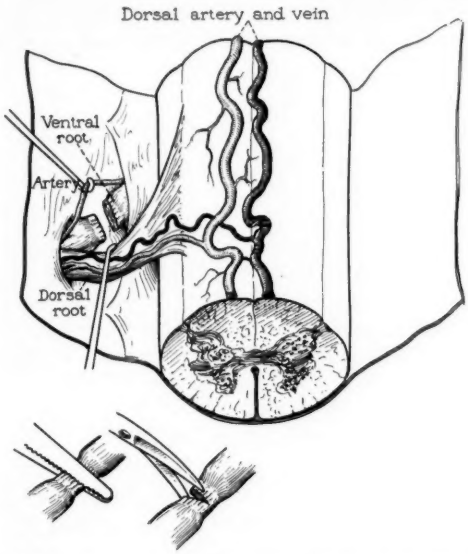

Fig. 4. Showing the technique employed in sectioning a ventral root while the arteries and veins about it are preserved.

biopsy or partial resection of the suprarenal gland. *Rhizotomy* has been used more often than splanchnic operation, since it is larger in scope and it would appear that more vasomotor impulses would be interrupted by that operative procedure than would be by the latter operation. However, inasmuch as rhizotomy is a formidable procedure, we have been interested in devising ways to reduce the surgical shock, but still produce as effective vasodilatation. One of us (Adson) therefore was prompted to devise a subdiaphragmatic technique of splanchnic resection with a lumbar sympathectomy.

The indications for the selection of cases and pre-operative preparation are the same for either operation. However, both procedures are being employed, not necessarily on alternate cases, but on similar cases in the various phases of the disease in order that we may evaluate the results from each procedure until one operative measure has shown results that definitely supersede those of the other. Once having selected the patient for operation, he or she should be permitted to quiet down thoroughly from the effect of the numerous

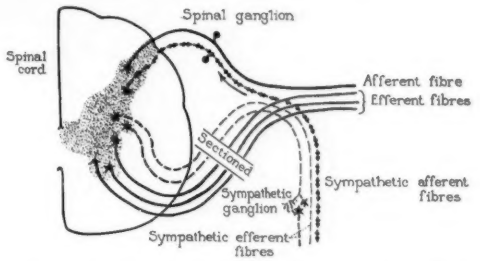

Fig. 5. Section of ventral root to interrupt preganglionic rami.

examinations before being submitted to operation. It may even be wise to administer small doses of amytal for 2 or 3 days and to give a dose of 3 grains (0.20 gram) of pentobarbital sodium on the morning of the operation 1 hour prior to transfer to the operating room. It has been observed that drop ether anesthesia, administered over an inserted intratracheal Magill tube, is as safe and satisfactory an anesthetic as we have employed. If no sudden and extreme rises or falls in blood pressure develop during the operation, we prefer to complete the rhizotomy in one stage.

RHIZOTOMY

On reflection of the dura, following the laminectomy, it is very important to avoid injury to the small arteries or veins accompanying each pair of roots. Those adherent to the ventral roots should be dissected free with delicate hooks. After these vessels have been separated from the ventral roots, it is not necessary either to ligate the root or to clip it with a silver clip, since the capillaries within the root between the fasciculi are readily crushed by compression of the root with a Kelly forceps preliminary to their division with a sharp scissors (Figs. 3, 4, and 5). The reason for protecting this blood supply is to assure the dorsal and ventral arteries and veins of the cord their collateral circulation. It is true that these communicating arteries and veins are not very large, but one of us (Adson) observed that a disregard for these vessels in performing ventral rhizotomy in one case resulted in permanent urinary retention. It is needless to urge hemostasis, for the experience of one of us (Adson), obtained in his first case, more

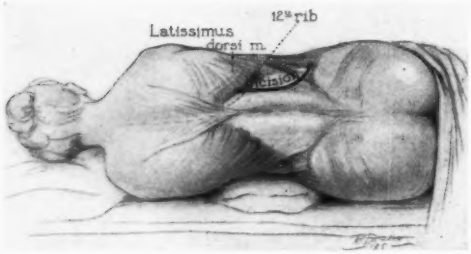

Fig. 6. Approach to the extraperitoneal subdiaphragmatic space in order to resect the splanchnic nerves, to remove the first and second lumbar ganglia, and to resect the suprarenal gland, for essential hypertension.

than emphasizes the importance that extraordinary precautions regarding hemostasis are necessary when laminectomy of such magnitude is undertaken.

One of us (Brown) has urged limitation of the extent of rhizotomy, and both Craig and Adson have employed modifications of the original procedure in that, in some instances, the bilateral ventral roots have been divided only from the sixth to the ninth thoracic segments. In other cases the roots have been divided from the tenth thoracic to the second lumbar segments, and in still other cases patients who underwent this partial rhizotomy have been submitted to the second stage, which included completion of the division of the remaining ventral roots carrying sympathetic impulses over the lower two-thirds of the thoracolumbar outflow. Postoperative observations and studies have shown rather conclusively that complete rhizotomy has been more effective than the limited one. Page and Heuer have made a very good suggestion, recommending that if the operation is to be divided into two stages, that it be divided at the completion of laminectomy before the dura is opened; thus, at the second stage of the operation, the time-consuming procedure of laminectomy is obviated and one can almost instantly proceed with section of the ventral roots.

EXTENSIVE SYMPATHECTOMY

The incision employed (Fig. 6), and the position of the patient on the operating table for extensive sympathectomy are similar to those employed for exploration of the kidney, except that the incision is made to follow anatomical lines. The line of the incision is similar to that of a hockey stick, with a staff portion placed just lateral to the rectus spinous muscles and the club portion extending obliquely downward and forward over Petit's triangle just above the crest of the ilium. At the upper portion of the wound, after the skin and subareolar tissue have been incised, the oblique fibers of the latissimus dorsi muscle are incised, thus exposing the twelfth rib. As the incision is extended downward along the course of the skin incision, the common aponeurosis of the external and internal oblique muscles, and of the transversalis muscle where it fuses with the lateral reflection of the lumbar fascia, is incised until the fusion extends into Petit's triangle, exposing the capsule surrounding the perinephritic fat.

The next step in the operation consists of performing subperiosteal resection of the twelfth rib (Fig. 7), care being taken not to injure the pleura; the finger is then introduced into the subdiaphragmatic space above the perinephritic fat in order to dissect free the subcostal ligament of the twelfth rib, since division of this will allow upward retraction of the structures, periosteum of the twelfth rib, intercostal vessels, and nerves, which affords a much better exposure of the splanchnic nerves and lumbar ganglions. A wide illuminated retractor is then introduced into the wound at right angles to the spinal column. It is used to displace the liver forward and downward and at the same time to lift the capsule about the perinephritic fat with its contents (the kidney and suprarenal gland) in a similar direction. Since the patient is placed on his side with elevation of the opposite loin with the kidney rest, it is not difficult to displace these structures forward and downward, care always being taken to avoid sudden or jerking movements. The tissues are further protected by introduction of a salt laparotomy sponge, with the retractor placed on the sponge to assure against trauma to the underlying tissues. Gentle dissection with moist cotton-ball sponges reveals, first, the splanchnic trunk, composed of major and minor and lesser splanchnic nerves, which are about 2 centimeters in length. Dissection is carried mesially until the lateral border of the celiac

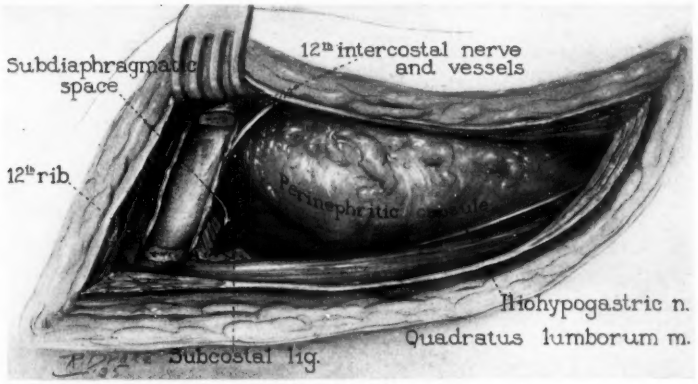

Fig. 7. Resection of the twelfth rib, with elevation of perinephritic fat and capsule, and division of the subcostal ligament, exposing the retroperitoneal subdiaphragmatic space.

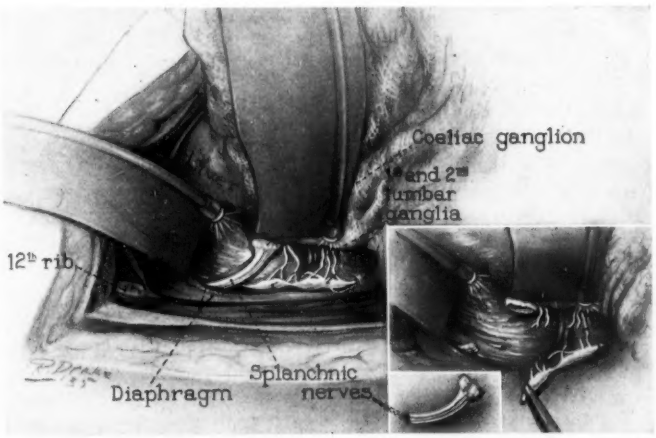

Fig. 8. Exposure and resection of splanchnic nerves, with a portion of the celiac ganglion, and removal of the first and second lumbar ganglia.

ganglion is exposed. The resection includes a few millimeters of the ganglion with the splanchnic nerves (Fig. 8). The first and second lumbar sympathetic ganglia are exposed in turn and are removed in conjunction with the intervening trunk in order to interrupt fibers that pass downward in the lower end of the thoracic sympathetic trunk as well as to interrupt white rami carrying efferent impulses to the upper two sympathetic lumbar ganglia.

After hemostasis has been thoroughly controlled, the liver and perinephritic fat capsule are allowed to fall into place before the perinephritic fat capsule is incised over the upper pole of the kidney. A Halsted forceps is then placed on the renal capsule just superficial to the peripheral border of the suprarenal gland (Fig. 9). Gentle retraction on the forceps elevates the upper pole of the kidney, and presents the suprarenal gland into the field. The gland is now so superficial that one can readily explore it, and resect any portion of the gland desired, without injury to the remaining portion. In light of the work of Crile and DeCourcy, one of us (Adson) has resected the

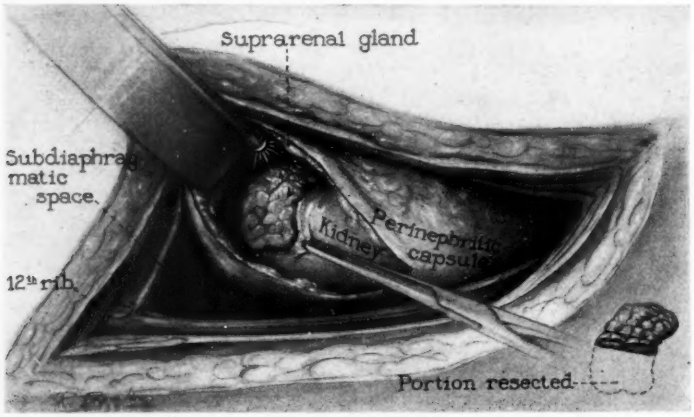

Fig. 9. Elevation of superior pole of kidney, with exposure of suprarenal gland, employing the same incision used for splanchnic resection and removal of lumbar ganglia.

outer half of the gland on each side in 6 cases in conjunction with splanchnic nerve resection and removal of lumbar ganglia. In doing so the outer portion of the gland is elevated from the kidney without injury to the blood vessels, since most of these enter the gland from the mesial and dependent portion of it. Two stick ties of double No. oo catgut are introduced into the middle of the gland, ligating first to one side and then to the other. The outer or distal portion of the gland can then be removed without hemorrhage or trauma to the remaining portion. The perinephritic fat capsule is closed with interrupted sutures of catgut and dropped into place. The kidney rest is then lowered, the muscular fascial planes are approximated with continuous and interrupted sutures of No. 1 chromic catgut (Fig. 10). The subareolar tissue is approximated with continuous No. 1 plain catgut. The skin is closed with interrupted silkworm sutures and approximated with a continuous locking stitch of dermal or silk sutures. No drainage is employed.

Postoperative care corresponds in the one instance to that which is employed in the treatment of patients who have undergone laminectomy for lesions of the spinal cord, whereas in the other instance it is similar to that which is employed in the treatment of patients who have had operations on the kidney or upon the suprarenal gland.

ANALYSIS OF RESULTS FOLLOWING OPERATION

The purpose of the operation is to destroy the vasomotor innervation to a large vascular area (Fig. 11) in order that those vessels which are deprived of their vasoconstrictor impulses will be unable to respond to the central mechanism and therefore be unable to take part in the general phenomena of vasospasm. While the vessels which have not been denervated continue with spasm, the denervated vessels dilate instead and act as reservoirs. It must not be forgotten, however, that the musculature of the heart and blood vessels is capable of responding directly to the pressor and depressor substances circulating in the blood stream, and that there is a possibility that these substances increase, or that the musculature becomes more active, as a compensatory factor following these extensive forms of sympathectomy. It is, therefore, further possible that this is the explanation for the surgical failures.

Operative procedures on the suprarenal gland suggest that a diminution of the secretion of epinephrine is a beneficial factor in the treatment of the disease. The evidence to date, however, is not conclusive or indisputable.

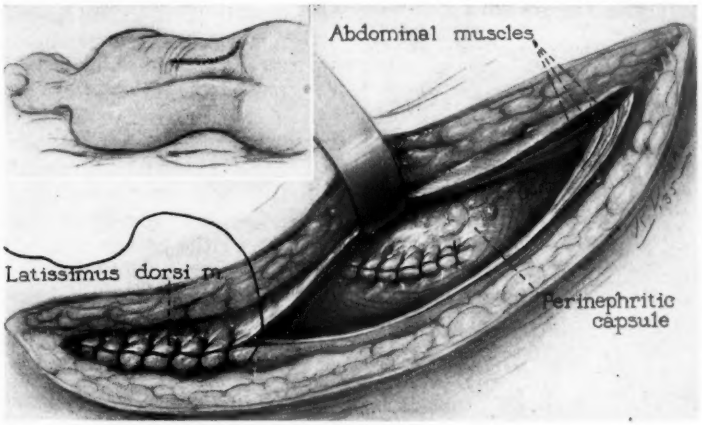

Fig. 10. Closure of wound in anatomical planes.

POSTOPERATIVE CLINICAL OBSERVATIONS

Promptly following one of these extensive operations the systolic blood pressure is capable of dropping from 270 millimeters or more to a reading of 100 millimeters of mercury, and the diastolic is capable of dropping from 170 millimeters down to 60 millimeters of mercury. The same observations have been found following either rhizotomy (Fig. 12) or splanchnic (Fig. 13) resection. As long as the patient remains in bed, these pressures remain low and the systolic pressure may not rise above 140 and diastolic not above 90 millimeters; as the patient gets up and about, however, the systolic pressure may rise to 160 or 170 millimeters and the diastolic to 90 to 110 millimeters. The most significant observation is that the sudden and abrupt peaks of blood pressure will not occur following operation as they did prior to operation. The variability in both the systolic and diastolic pressures, and the mean pressures of both, have been materially reduced. A review of our series of rhizotomies shows the mean systolic drop to be 44 millimeters and the mean diastolic drop 38 millimeters of mercury. Improvement in clinical symptoms is probably more manifest than the actual drop in blood pressure, since these patients very promptly inform us that their throbbing headache, cardiac consciousness, and precordial distress disappear. The ocular symptoms as well are markedly im-

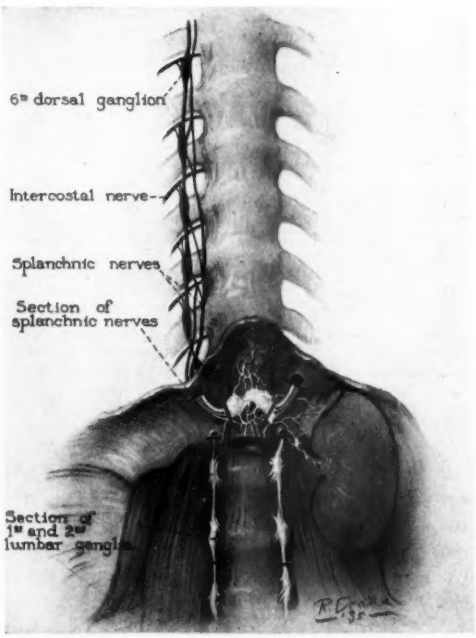

Fig. 11. Schematic drawing showing the splanchnic nerves and celiac and lumbar ganglia, and as well the lines of resection and the effects which are produced when the splanchnic nerves are resected and the first and second lumbar ganglia are removed on each side. The sympathetic ganglia which have been shaded dark represent those which receive efferent impulses, and those that have been left light have been deprived of these impulses.

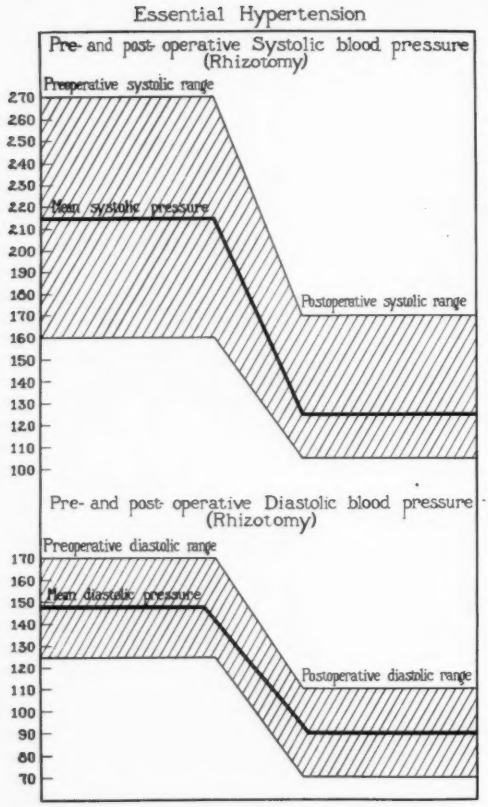

Fig. 12. A typical case of essential hypertension, showing the range of systolic and diastolic blood pressures taken over 24 hour periods before and after extensive rhizotomy. The postoperative readings represent the decrease in blood pressures, with a decrease in the range of systolic and diastolic blood pressures, recorded after a postoperative interval of four weeks.

proved. Spasm of the retinal artery is less, a phenomenon which is difficult to understand since these vessels have not been denervated by either the rhizotomy or splanchnic resection. It would thus appear that part of the spasm is a defense mechanism to protect against rupture, but which also works in a vicious circle to contribute to the phenomena of vasospasm and hypertension. The reduction of blood pressure seems to diminish the reflex stimulus, which accounts for some of the relaxation of the vessels as observed by studies of the retinal arteries in the various phases of the disease and its treatment. Retinal hemorrhages and papilledema will often disappear following sympathectomy. If the damage to the kidneys or heart or brain has not been too extensive, a moderate degree of improvement may be anticipated.

Laboratory studies reveal that there is a definite water lag during the day when the blood pressures are lower than during the night when the patient is in a reclining position. A moderate polyuria at night may appear to compensate for the deficient excretion during the day. Excretion of dye is not influenced by low pressures. There has been no change in the sugar tolerance and also no change in the creatinine or serum sulphates. Patients with renal damage presented high values for urea immediately after operation, a condition which corrected itself by the time of dismissal 4 weeks after operation. The "cold pressor tests" following operation produce lower levels, with smaller variables, following operation than they did before it. Readings of blood pressure in the various positions, such as the erect, reclining, and Trendelenburg position, reveal definite evidence of hypotension, a situation that occurs frequently following extensive rhizotomy and has occurred following extensive splanchnic resections. The systolic blood pressure is capable of dropping to such an extent that, when the patient is standing in the upright position. syncope occurs; but, fortunately, it can be corrected by applying an abdominal supporter and adjusting the tension.

The results of the various operations have been compiled in chart form in an attempt to evaluate the accomplishments of the various operative measures (Table I). The groups for each operation have included about an equal distribution of benign, early malignant, and malignant, hypertensions. Two deaths have occurred, one resulting from hemolytic streptococcal meningitis, and the other from a ganglioneuroma with advanced cardiorenal degeneration. In this last case death probably was due to cardiac failure, as it occurred very suddenly after the patient had recovered from the anesthetic. The patient's blood pressure rose to 300 millimeters of mercury systolic at the first attempt at rhizotomy and operation

TABLE I.—RESULTS OF VARIOUS SURGICAL PROCEDURES FOR ESSENTIAL HYPERTENSION—1935.

Type of operation	Cases	Results			
		Good	Fair	Failures	Deaths
Extensive rhizotomy	27	13	6	6	2
Splanchnic section with removal of first lumbar ganglion	7	2	1	4	0
Splanchnic section with removal of first and second lumbar ganglia and partial section of suprarenal gland*	7	5	2 (one side)	0	0
Miscellaneous	4			4	0
Total	45	20	9	14	2

Average systolic drop: 44 mm. of mercury
Average diastolic drop: 38 mm. of mercury

*Ten additional patients have been operated upon.
No deaths, results very satisfactory. Suggests that this operation is the one of choice.

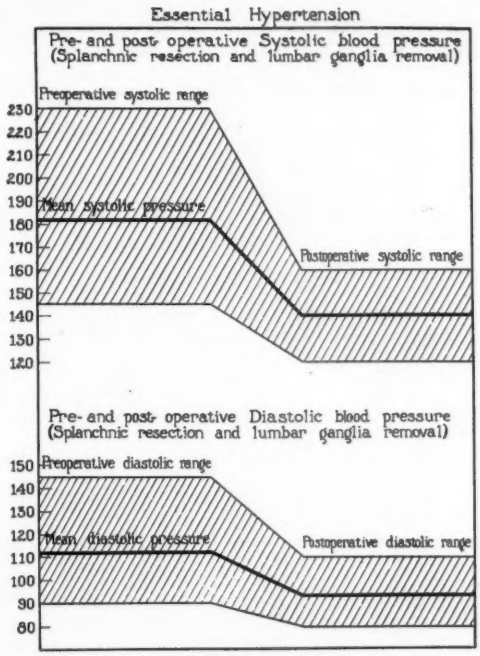

Fig. 13. A typical case of essential hypertension, showing the range of systolic and diastolic blood pressures taken over 24 hour periods before and after bilateral splanchnic resection, bilateral removal of first and second lumbar ganglia, and bilateral resection of suprarenal glands. The postoperative readings represent the decrease in blood pressures, with a decrease in the range of systolic and diastolic blood pressures, recorded after a postoperative interval of 4 weeks.

was therefore postponed without making an incision. At the second attempt, even though the patient was "saturated" with pentobarbital sodium, it again rose above 270 millimeters systolic. Following completion of the operation, the blood pressure had dropped to 90 and 50 millimeters of mercury, respectively. The four miscellaneous operations, as previously stated, included limited procedures to determine what influence they might exert on lowering the blood pressure. We have previously commented on the effects of lumbar sympathectomy and unilateral cervicothoracic sympathectomy. Division of the intercostal nerves, from the sixth to the eleventh roots on both sides in the postaxillary line, produced paralysis of the abdominal muscles with a drop of systolic pressure of 10 to 20 millimeters of mercury, a drop in blood pressure of no significance. The fourth case, in which the suprarenal glands were resected without inclusion of sympathetic nerves, will undoubtedly be reported later by Walters. The results, as far as influencing blood pressure are concerned, are rather disappointing.

SEQUELÆ FOLLOWING RHIZOTOMY AND EXTENSIVE SPLANCHNIC SECTION

Following complete rhizotomy, there is loss of the sweating function of the feet, legs, and lower part of the abdomen up to a transverse line situated about 1 to 2 inches (2.5 to 5 centimeters) above the umbilicus. The skin is slightly pinker than normal in appearance and is definitely warmer, thus producing the same vasomotor phenomenon that follows bilateral lumbar sympathectomy. There is a paralysis of ejaculatory powers and muscles of the urogenital trigone similar to that following neurectomy of the presacral nerves. This phenomenon does not alter the menstrual cycle or does it disturb the child-bearing functions in the female, but it does result in sterility of the male although it fortunately does not disturb the potentia or the libido. Though rhizotomy deprives the small and large bowels and the bladder of their sympathetic innervation, it does not appear to increase the frequency of urinary or fecal evacuation.

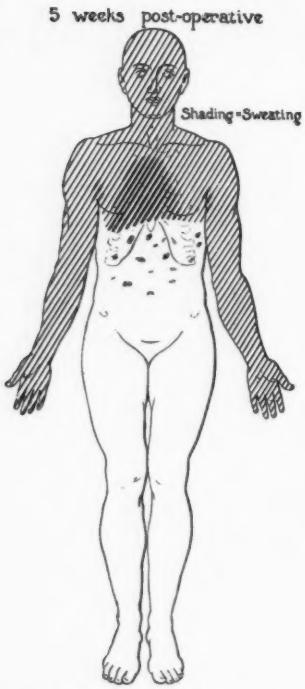

Fig. 14. Areas of skin in which the sweating function has been ablated by an extensive rhizotomy for essential hypertension. The operation included bilaterally, the ventral roots from the sixth thoracic to the second lumbar segments.

The effects of splanchnic resection and removal of the first and second lumbar ganglia are similar to those obtained by rhizotomy, except that the level of sweating and sebaceous loss and increase in surface temperature occurs at a lower level than that observed in rhizotomy (Fig. 14). Since the level in this latter group corresponds to the first lumbar segment, this loss of sweat secretion and the vasomotor relaxation continues downward from this level to include the feet. Though it appears that the autonomic nervous system, and particularly the sympathetic nervous system, plays an important rôle, according to Cannon, in the regulation of the homostasis of the human body, it is possible for human beings as well as experimental animals to live without its influence, in limited areas at least.

SUMMARY AND CONCLUSIONS

Analysis of the data following surgery indicates that certain definite results have been obtained by these extensive operative procedures. However, it also shows that a limited number of patients fail to respond to the same procedure, while still others have obtained clinical improvement without a material drop in blood pressure, some of them having had a return of their old symptoms and of their high blood pressures. The interval following these surgical procedures is too short to prognosticate what the ultimate results will be. One of our patients has now survived for approximately 5 years, but the remaining group have survived 25 months or less. The immediate effects in many cases have justified the surgical treatment, and they have encouraged us to continue with the operative measures in the hope that better selection of cases may be made and that subdiaphragmatic splanchnic resections with removal of the upper two lumbar ganglia and resection of the suprarenal gland may be more effective in controlling or relieving symptoms of essential hypertension than the operation of bilateral ventral rhizotomy of the thoracic and lumbar roots, extending from the sixth thoracic to the second lumbar, inclusive.

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THE MEDICAL PROBLEM AND MANAGEMENT IN ESSENTIAL HYPERTENSION[1]

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THE history of the early attempts to read the secrets of the pulse, the circulation, and the pressures within the vessels would provide an interesting chapter. Read the delightful account by Brim running from Herophilus and Galileo through Harvey, Hales, Poiseuille to Herisson; the last named, the first to invent a blood pressure apparatus to measure the blood pressure in man. From there his account carries on from von Basch, who is said to have made the first actual scientific blood pressure measurements in man, to Riva Rocci, to whom we owe the prototype of the sphygmomanometer in widest clinical use today. On the way we meet Frederick Akbar Mahomed in Guy's Hospital, from whose paper "On Albuminuria" in 1883 Brim quotes: "Lastly, I may point out that I have demonstrated that the increase of arterial pressure precedes the appearance of any symptoms of renal disease." This terse sentence is expressive of Mahomed's discovery of the pre-albuminuric stage of hypertension.

The similarity in the histological changes found in the kidney when sclerosis of the renal arterioles causes closure and consequent atrophy of the glomerular capillaries and in the changes seen in chronic glomerulonephritis has long caused confusion in our ideas as to etiology and consequently in our methods of management as well. It has taken the greater part of the century since the publication of Bright's classical work in 1827 to clear away the confusion these similarities have brought about. This is being accomplished by the slow and painstaking processes of investigation by innumerable workers in the clinic and laboratory, in chemistry, and in physiology.

In recent years much of the confusion between the histological picture in chronic glomerulonephritis and that in essential hypertension is cleared up by recognition of the fact that in the latter, the arteriolar lesions precede the lesions in the glomerulus. In describing the arteriolosclerosis kidney, Bell states that as the lumen of the arteriole becomes narrowed, the glomerular capillaries collapse and the basement membrane increases until the entire glomerulus assumes a compact hyaline appearance. The closure of the glomerular capillaries brings about a disuse atrophy of the associated tubule. Closure of small arteries causes atrophy of groups of glomeruli and their tubules. When a sufficient number of tubules have atrophied, the cortex shrinks and the surface of the kidney becomes pitted. Renal insufficiency develops when the atrophy becomes pronounced. Sclerosis of small arteries is as important as arteriolosclerosis in causing atrophy and renal insufficiency.

Further, the development of uremia in essential hypertension during the stage to which Fahr gave the name "malignant hypertension" serves to emphasize the toxic and degenerative features and to make most investigators give consideration to the idea that there must be some toxin responsible for the retrogressive changes both in the arterioles and in the small and large arteries. Probably the most outstanding recent work expressive of this search for some specific toxic substance causing hypertension is that of Major, who demonstrated in animals prolonged elevation of blood pressure following injection of guanidine. He found guanidine present in the blood in increased amount in 15 cases of chronic nephritis, in 13 of which there was a coincidental retention of nitrogen. He found also increased guanidine in the blood in 61 per cent of his patients with essential hypertension but did not differentiate between the simple, benign, and "malignant" forms. The search for a pressor substance in nephritis and renal toxemias does not concern us here.

A differentiation between the vascular changes in decrescent arteriosclerosis and those changes occurring in association with arterial hypertension is possible because of the fact that with the latter condition, sclerosis of the small arterioles—arteriolosclerosis—is usu-

[1]Presented in the symposium on Hypertension before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

ally present in the more advanced stages. Bell (2) states that typical clinical cases of hypertension are frequently seen in which no arteriolosclerosis is found. He cites this as a fact in support of the view that arteriolosclerosis is not the cause of hypertension.

In this condition the most recently expressed view of Bell (3) is: "It seems more satisfactory at present to use arteriosclerosis in a broad sense to include all non-inflammatory forms of arterial disease and to recognize, as Hueck does, that it is a collective term embracing a number of different processes which may or may not have a common etiology. Special types may be distinguished on a basis of anatomical structure until distinct etiological factors are determined." Within the broad group of arteriosclerosis, he considers arteriolosclerosis a special anatomical type, "apparently due to increased intravascular pressure." We have no reliable information as to why certain vascular areas are affected and others are not.

It is probable that there is no living pathologist whose work has been more widely accepted or whose views have been generally accorded greater respect than that of Aschoff. In his introduction to the volume on arteriosclerosis by many writers, published in 1933, he has summarized his views and given his definition of the functional, degenerative and dystrophic diseases of the vascular system. Extensive and necessarily incomplete quotations would wrench his statements from their context, but an attempt will be made to put in very succinct form some of the views he expresses. In contradistinction to arteriosclerosis, an affection of the arteries properly so called, arteriolosclerosis is an affection of the precapillary arterioles, "usually manifesting itself by hyaline and lipoid imbibition on the part of the vascular walls which swell up to such a degree that the lumen may be completely occluded." It is fairly certain that its origin is in a functional stimulation of the vascular system which manifests itself by hypertension. In the incipient pre-arteriolosclerotic state, the arterioles may still be quite free from actual disease. The not infrequent bursts of hypertonia in early years are evidence of its independence of arteriolosclerosis. Hypertonia leads to disease of the smallest arterioles, especially of certain organs (heart, kidneys, brain), especially if it becomes fixed in the course of advanced years. "If it is at all justifiable to advance an opinion at this time, it would seem that the hypertonia is to be regarded as the cause of arteriolosclerosis of these vessels."

In a recent contribution to the discussion on elevated blood pressure, Volhard distinguishes "pale hypertension" from "red hypertension." He discusses the relative importance in each of the chemical or hormonal, and the nervous regulatory mechanisms. In the first group, the patients are pale, which he believes must be caused by contraction of all vessels, arising through a chemical, humoral mechanism only. In this group belong nephritic patients with a tendency to develop angiospastic retinitis. He says: "It is difficult to imagine that a hypertensive condition in which the arteries of the brain and the retina are constricted can be brought about by a nervous mechanism." Pale hypertension develops also in certain forms of chronic hypertensive disease leading to deterioration of kidney function and malignant hypertension. It is his conclusion that a two-fold relationship probably exists; the vasoconstricting substance or substances being the product of a diseased kidney and also a toxicant to the kidney, leading to renal insufficiency through lasting circulatory disturbances. Of his red hypertension, the group today usually called genuine or essential, he says: "It is easier to state what it is not, than what it is. It is neither caused by general vasoconstriction, nor is it of chemical nor of purely nervous origin. It is not, as the author earlier used to believe, of renal origin." He stresses the fact that this red hypertension is prominently a disease of old age, very seldom occurring before 30, rarely before 40, frequently between 40 and 50, and most commonly between 50 and 70 years of age. He is inclined to believe that heredity, besides age, plays an important rôle, and he feels inclined to credit the existence of a hypertensive constitution, instead of the usual assumption of an abnormal excitability of the vascular system. He leans more to the assumption of an inferiority of the vascular system mani-

fested perhaps through an early vasoneurosis, but states: "It is, however, possible that the wear and tear of a normal vascular system become accelerated through an inherited vasolability expressing itself by abnormally strong and frequent blood pressure fluctuations of nervous origin."

Volhard considers red hypertension a benign disease in so far as the kidneys are concerned, a benign nephrangiosclerosis, and he distinguishes a cardiac, cerebral, or pancreatic course of the condition. On the basis of this benign condition in certain cases, the splanchnic and renal angiosclerosis may suddenly develop into a malignant and progressive renal disease, renal insufficiency and true uremia, the contracted kidney. Volhard shows that the sudden turn in the course of the disease has never been fully understood, but considers the development of a vicious circle in which the renal vessels become less and less capable of dilatation; the free vasomotor play diminishes, and the renal blood supply becomes smaller and more dependent on the blood pressure which becomes more stable at a high level.

Recent advances have given information of a fundamental character as to the functions and interrelationships of the glands of internal secretion. Witness the clearly demonstrated functional relationship between the pituitary and ovaries. While it is clear that certain cases of arterial hypertension result from disorders of some member of that group known as the endocrine glands, a small percentage of the cases of suprarenal tumor being the clearest illustration, it must be recognized that the common malady known as essential hypertension is not due to structural abnormality, but that if the endocrine system is involved in the production of essential hypertension, the method of that production must be an essentially normal one involving the mechanisms of the autonomic nervous system. Reactions that are normal in character may be excessive in degree, and may be elicited over excessive periods of time and by stimuli less than those required by the average individual. Individual differences in reaction to the same stimulus exhibited by members of the same animal species are among the most interesting phenomena in physiology, and are well known by the experimental physiologist working with lower animals. Such great differences are seen every day in the reactions in man to a stimulus or to a drug, and the clinician is ready to credit their occurrence in the field under discussion.

During the period when essential hypertension was regarded as a result of primary disease of the kidney with the retention of pressor substances, these substances were generally thought to be the end-product of protein metabolism. At another time, the excessive ingestion of protein food was considered. The appearance of hypertension in many gouty subjects drew attention to purine metabolism. Fat and lipoid metabolism have been the subject of much attention in two directions: the first being the frequent relationship between essential hypertension and obesity, and the second relating to cholesterol metabolism. Experience teaches that in the obese with hypertension, dietary restriction and weight reduction are often accompanied by a very satisfactory reduction in average blood pressure readings, but many of the obese without evidence of cardiac weakness have readings which are normal and below normal. There have been many facts suggestive of a relationship to cholesterol, particularly because of its intimate relationship to arteriosclerosis. Even in this condition, however, Wells looks upon the lipoids not as a primary factor but a secondary. Carbohydrate metabolism has received attention largely because of the frequent occurrence of hypertension in elderly diabetics, and also because hyperglycemia is not uncommon in essential hypertension. The relation of sodium chloride in the organism has received attention, and other electrolytes of the blood have been and are being studied. Overeating in general, gluttony, was long held to be the cause of hypertension. However, no constant relation between any of these factors and hypertension appears to exist, and it seems more than probable that the constitutional tendency to hypertension, whatever may be its cause, is the most important factor in the appearance of the hypertensive state. Some of these factors may be considered as remote or even

precipitating, but their inconstancy in essential hypertension makes a primary relationship impossible.

In a recent paper the author discussed the part played by heredity and by hyperirritable vasomotor mechanisms in the causation of essential hypertension. The opinion is expressed that heredity acting through excessive pressor responses on the part of the individual, is the dominant factor in producing the condition. In the early stages, the blood pressure shows a marked excessive lability with upward excursions far greater than those shown by normal individuals. It has been shown that differences between the lowest and the highest systolic pressure of 30 and 40, and often as great as 60 to 70 millimeters of mercury and more, may be readily obtained. Changes in diastolic pressure in the same direction but of lesser degree occur with resultant and significant elevations of mean pressure. In the normal individual examined under similar circumstances, the fluctuations are seldom greater than 20 millimeters systolic pressure and 8 to 10 millimeters diastolic pressure. We occasionally see in the clinic, individuals whose basal or resting blood pressure is normal and does not exceed, let us say, 140 millimeters; who exhibit while under certain stresses, elevations of pressure much like those shown in the labile stages of hypertension. The fluctuations may be obtained in a patient lying comfortably and passively in a semi-darkened room, the only variant being the subject of conversation by the examiner. If matters causing concern, anxiety, worry, or irritation are introduced, sharp elevations of pressure may occur. Leave the patient lying quietly alone, cautioned against any attention or response when the examiner returns, and, on returning, measure the blood pressure: it will be found that a greatly lowered reading may be obtained. These fluctuations are affective phenomena in response to emotional states. They are brought about by mechanisms in the nervous system, normally in operation but abnormal in the degree of response. In the individual with fixed or permanent hypertension, the basal level from which they arise is also abnormally elevated.

The complex mechanisms in the nervous system involving end-organs, afferent and efferent pathways, centers and reflex arcs, are outside the scope of this paper. Their discussion belongs in normal and pathological physiology, but no clinician, either medical or surgical in his outlook, can afford attacks on this problem without profound fundamental knowledge in the field.

The lengths of time during which a patient may sustain essential hypertension in a benign, relatively harmless form are not yet known. Individual variations both in the length of time and in the height of the pressure sustained are so great that no accurate relationship between the two can be found. It is true in general that the higher pressures are less well borne. There is a difference, difficult to explain, in the individual tolerance on the part of the cardiovascular system to the unusual stresses. Some individuals whose recorded pressures are in the lower hypertensive ranges succumb relatively early; while a smaller proportion of those in the higher ranges respond to these stresses with surprising endurance. The cause for these deviations from the expected can only be surmised. Constitutional, probably inherited, differences in the resisting power and tissue reaction on the part of these different individuals would be an adequate explanation. The actual cause is yet unknown. I have recorded one patient, aged 85, on whom I have records of hypertensive readings beginning 25 years ago. Two years ago at the end of 23 years of observation, the evidences of cardiovascular or renal damage in any form whatsoever were minimal. I have no records on other patients covering a similar length of time but have a few records covering periods of 10 and 12 years.

Why it is that a small proportion, approximately 10 to 15 per cent, of the patients with essential hypertension develop the so called malignant form is not known. These patients might well be individuals with a cardiovascular renal system particularly susceptible to hypertensive stresses inherited or otherwise, but such factors have not yet been established.

In 1933 Hines and Brown described a standardized test for measuring the variability

of blood pressure, utilizing the effect of cold applied to the hand and wrist opposite the arm used for studying the blood pressure response. This test, which is easily performed, makes it possible to study the reactibility of the pressor mechanism in large numbers of individuals. They conclude that at least 98 per cent of all subjects with hypertension of the essential form exhibit excessive reaction to local cold. They state that normal subjects can be grouped as those with minimal and those with excessive responses of the systemic blood pressure to sensory and psychic stimulation. The character of the pressor response to local cold has been confirmed by others (5, 7, 12). In a further report of which they have shown me the manuscript, Hines and Brown (10) report studies in 571 normal and hypertensive subjects and amplify their original conclusions. They classify the subjects into (1) "normal reactors," (2) "normal hyper-reactors," and (3) "essential hypertension." It is of special interest that of 8 hyper-reactor normals they reported in 1932, 3 had developed at this time clinical degrees of essential hypertension with elevation of blood pressure and demonstrable hypertensive changes in the retinal arterioles. They submit the conception that essential hypertension affects only subjects who are hyper-reactors and that an abnormality of essential hypertension is an excessive response in the blood pressure to intrinsic and extrinsic stimulation.

The writer has been studying for many years the blood pressure response to emotional states in hypertensive patients and has attempted management of the early labile stages, with a view of shortening the periods of each day during which the blood pressure is elevated and of lengthening and multiplying the periods of lower pressure. This is based on the definite opinion that the too frequent recurrence of these excessive responses is the primary factor in producing higher and more fixed elevations of blood pressure along with cardiac hypertrophy and vascular changes. Thus the proper emphasis in the management of essential hypertension lies in the control of the frequency and character of the emotional stimuli and of the affective pressor response. This requires understanding of the patient's problems, much patience and ability in instruction, and leadership on the part of the physician. The purpose in management is to modify the environment and its effect on the pressor responses. We may not be able by rational methods to control the degree of response to a given stimulus, since this degree appears to be inherent in the mechanism of each individual. We can, however, by control, shorten the periods of heightened pressure and lengthen the periods of lower, basal, or near basal, pressure. The methods of approach to these problems will vary with every physician. No attempt at detailed explanation of any method of treatment can be attempted here. I have learned, however, to follow certain principles and having followed them, have seen responses to management and control which, though not brilliant, have been very satisfactory. I will cite 2 cases in briefest possible form:

CASE 1. J., male, was first seen in 1921 at the age of 57 years and a diagnosis of essential hypertension was made. In the first 2 years of observation, the highest pressures found were 220/118 and the lowest were 185/100. In 1923 gastro-intestinal symptoms developed, evidences of duodenal ulcer were found and medical management was undertaken, but bed rest was refused. Ambulatory treatment was inadequate and acute perforation required gastro-enterostomy on May 20, 1926. On June 28, 1929, cholecystectomy for gall stones was performed. During the year preceding the last operation, the highest readings obtained were 215/103 and the lowest, 162/82. Although he showed marked lability of pressure and some response to relaxation, I felt that because of his gastro-intestinal condition and of undue stresses in his business and his family, satisfactory control was not secured. Following the operation and at my insistence, radical adjustment in his responsibilities was made. He gave up many tasks and responsibilities he had been carrying for others and for the community. This was done willingly and with his full co-operation and understanding. When these adjustments had been secured and for a period of nearly 4 years following, pressures on beginning an examination were usually in the order of 200/110 to 185/100, and after a few moments' rest, pressures near and about 145/95 were commonly secured. At the end of this 4 year period, increasing responsibilities in his business through death of a brother, together with a resumption of certain favorite community responsibilities, were followed by return of pressure to nearly the readings given for the first year. Since then the condition has seemed almost stationary except for the development of evidences of moderate left

ventricular hypertrophy. He is an active and effective man of 71 years now, 14 years after the discovery of his hypertension, moderately controlled over the greater part of this time, with a period of nearly 4 years of amelioration of the high pressure brought about, I believe, by management with his intelligent co-operation. The program was broken up later by unavoidable causes.

Conditions in the second case were very similar:

CASE 2. W., first seen in 1923 at the age of 55 years, an alert, strenuous and effective bank executive exercising a great deal of supervision and spending long hours at his work. A mild arthritis for which he had sought advice subsided under management. The blood pressure reading secured on the initial examination was 165 systolic and 100 diastolic. Similar readings were secured at long intervals, but were disregarded by him until 1927 when blood pressure records of 180/95 and 170/100 were secured during a strenuous reorganization and expansion program on the part of his institution. A full exposition of his situation and needs was made to him. Complete co-operation was secured, and for 3½ years, readings at 3-month periods or oftener showed, as first records, for each visit such as 145/82 to 158/88, and after a few minutes' relaxation on the examining table, repeated records such as 128/79 and 132/78 were made. At the end of the 3½ year period, an osteo-arthritis involving the spine, the hip girdle and the shoulders, elbows, and wrists began to be manifest again and with this, pressures near his 1927 figures developed and showed some unfavorable progress for the 4 years that have elapsed. Osteo-arthritis made a profound and unfavorable impression upon him because of previous history of the affection in his family.

These are not isolated cases nor are they very common.

In the majority of cases the foundation for management is laid during the first interview, and just as soon as it can be determined that we are dealing with the essential type of hypertension, two purposes are kept in the foreground and maintained throughout. The first is to demonstrate to the patient that some drop in pressure can be secured by rest and relaxation. The patient is not allowed to see the manometer during the period of study of blood pressure but when the examination is finished, is informed of the readings with particular emphasis on the degree of lowering secured. The second purpose in management is to acquaint the patient with the fact that essential hypertension is usually a benign disease and that, with proper co-operation and attention to his condition and his emotional responses, the usual outlook is favorable. Attention to these points is necessary because if not forestalled, the patient often develops from his relatives and friends a very distorted and pessimistic outlook. One of the most curious gestures by the friends of any one in whom some malady has been discovered is to carry to him with all the horrendous detail possible, innumerable stories of this or that one gone to his fathers by the same route. The early anticipatory recital of the state of health and strength of one or more long-lived patients goes further in my experience toward establishing a favorable viewpoint than does a more theoretical discussion, even though the latter is backed by real knowledge of the subject. I attempt also to convince the patient that the problem and course of some other patient whose disorder has the same name or who may have one or more of the same symptoms are in no sense his problems and course. The warning requires reiteration throughout the course of management. I have said elsewhere and repeat here that I am sure that one of the most vicious effects of neighborhood medicine is to wreck very many well thought out and intelligently conceived medical programs which would otherwise be effective.

It has been my experience that one of the most effective measures in the management of the early and labile stages of essential hypertension is to furnish the patient with knowledge of, and repeated experience in, the lowering of blood pressure to be secured by relaxation. If he can be shown that when he is relaxed and serene, his blood pressure is lowered, but when he is on tension, hurried, and worried, his pressure is up, and can be shown this very early, he himself will have an understanding of the benefits of relaxation and through his own knowledge will be ready to co-operate. For this reason it is my custom to tell a patient at the end of an examination what the entire series of blood pressure readings have been, with an explanation for the differences. I give the exact readings. I have at once secured his interest in a procedure novel to him; have secured his confidence; and have shown him something he does not know about blood pressure. This sounds too simple

to be true, but the effect is usually profound, and I am given as much opportunity for control as the mentality and circumstances of the patient will allow. We are dealing with different capacities to receive impressions and to work out effective programs. If radical changes in the philosophy of life and in those segments of the environment responsible for undue stresses can be successfully engineered, a pronounced shortening of the high pressure periods can be brought about. This may result, and in my experience has repeatedly resulted, in a virtual disappearance of the major blood pressure elevations. I am referring here only to the early labile phases before organic changes have become demonstrable and before persistent fixed pressure elevations have developed.

I have attempted to place the emphasis in management of essential hypertension on the early labile phases and would include here those individuals whose basal pressure may not be that of the definitely hypertensive but who show pressor hyper-reactivity. The discovery of these individuals in the early stages of the condition is a major problem in medicine. Life insurance examination, health examination, and the adoption of blood pressure determination as a routine in all clinic and hospital admissions result in the discovery of a fair proportion of these cases. Student health services in colleges and routine examinations in schools should take further note of hyper-reactors and provide for follow-up, since it is at this stage that environment and emotional control should be most effective.

The prevalent practice of recording the lowest pressures secured rests on the false assumption that these are the characteristic pressures. It is my belief that the characteristic pressures are the highest ones to be secured under stimuli in general of an emotional character. To learn the order or degree of stresses sustained, these stimuli should simulate as nearly as possible those in the environment normal to the individual. I have found the results of the local cold stimulation test of Hines and Brown, previously referred to, parallel quite closely to the results of study of emotional pressor response. The ease of application and the definite reaction make it a satisfactory procedure for the routine testing of large numbers of subjects. It discovers certain hyper-reactors not otherwise readily found. When thus discovered, a study of emotional factors will usually reveal similar reactions. The utmost importance attaches to the discovery of hyper-reactors and early hypertensives in early life.

Discussion of the management of the later, more severe, fixed and malignant types of hypertension and of the results of organ damage in essential hypertension is not desirable here. While it is true that in these phases the most favorable time for effective management has passed, much can be accomplished by readjustment of the environment, readaptation to that remaining environment that cannot be changed and by retraining and reconditioning the individual. Specific regimens of rest, of drugs, of diets, and of deprivations, such as of common salt, are not the answer to our quest for an effective therapy. A high degree of individualization in management is necessary, and, with it, gratifying results are often obtained. Until or unless we possess more adequate knowledge of the pressor mechanisms and factors conditioning them, we must be content with medical methods short of the ideal, but still measurably effective.

A surgical attack on the pathways of the pressor mechanism is mutilating to the nervous system and can be justified only in certain rare instances and with avoidance of disabling effects other than those on this mechanism. It is to be hoped that papers in this symposium will make clear the indications for surgical procedure. We recall the great service rendered by surgery when it added to our knowledge of living gastric and duodenal pathology. In the process, the indications for gastro-enterostomy were not clarified early, and the operation was popularized and was performed in many quarters and by many men unnecessarily. One is justified at this time in expressing the hope that procedures less severe, less crippling, and non-operative in character, may be found before a corresponding number of ineffectual operations are performed in the demonstration of the pathological physiology of essential hypertension.

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CEREBRAL INJURIES DUE TO EXTERNAL TRAUMA[1]

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CEREBRAL lesions due to external violence challenge the ability of the surgeon to diagnose accurately the extent of injury to the skull, meninges, blood vessels, water reservoirs, and cerebral tissues; to give immediate and continuous personal attention during the first few hours and careful direction for the following few days so that the accepted medical and surgical procedures are properly executed; to prevent the unnecessary posttraumatic sequelæ so common to these accidents, by the proper selection of immediate personnel with whom the patient will be associated during the period of unconsciousness and later readjustment to unusual conditions; to assist in the establishment of hospital equipment, service, and personnel so that emergency cases may have the advantage of the correct treatment during the first 3 hour period; to train nurses and internes in their various duties so that they may do their part in the treatment of these cases; to keep accurate records and publish from time to time the results of the successes and failures from this or that method of treatment in order to give others the benefit of this work and these observations; to apply the laws of cerebral hydrodynamics and the pathology of altered normal physiology as it applies to this problem.

This is the challenge to the surgeon of today. How well it has been answered in the past 15 years is well known to all who are conversant with the literature, but of late there has crept into the reports and discussions of this problem, a note of pessimistic fatalism not in keeping with the traditions of surgery: advice tending to trust the care and future of the injured person to the tender mercies of time, aided by the proverbial ice bag at the head and a prayer at the foot of the bed, and watchfully awaiting a sign or symptom demanding surgical relief, seem to be heralding a return to the period of the early twenties rather than boldly accepting and mastering and teaching the lessons learned during the early thirties. It is a challenge which we cannot put aside.

Each year approximately 125,000 injuries involving the head and spine occur in America. The number mounts year by year, as the result of increased speed of transportation and mass production in industry. America is on the move and we must do our part in meeting these accidental casualties of modern mania for speed in all of life's activities.

During the period immediately following the war, there was no accepted method of treatment for severe cerebral injuries, except in the cases of compound depressed fractures or intracranial hemorrhage when operative measures were universally employed; decompression operations were advised whenever the pulse pressure and pulse rate crossed; spinal drainage and the use of hypertonic solutions intravenously were not at that time universally employed. Classification of injuries and reports were based upon the particular region of the skull and brain involved rather than upon the character and type of injury. A sufficient number of cases reported had not as yet shown the relative importance of various methods of treatment or the other factors which are involved in the present conception of this problem. A report of our work covering the cases treated at the City Emergency Hospital in Seattle during the years 1919 to 1924 showed (Table I) 178 cases, with a mortality of 60.7 per cent. The report classified the cases as to location of the fracture and part of the brain involved. The operative incidence was 18 per cent and the operative mortality was 37.5 per cent. This is indeed a sad report compared to the present day statistics, and yet it was an accurate, though disheartening, record.

With the advent of the use of hypertonic solutions for the control of intracranial pressure, with the better knowledge of the purpose of the reservoirs of fluid within the ventricles and cisterns of the brain and the method of preserving these water reserves and measuring the water content of the blood; with better knowledge of the value of spinal drainage and decompression operative pro-

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cedures; with the increased value of blood and pulse pressure in the determination of the relative clinical condition of the patient, the mortality rate has been essentially lowered. Of greater interest perhaps is the lowered morbidity rate and prevention of post-traumatic sequelæ as the importance of the use of these measures has been revealed during the past few years.

In 1932 a second report covered the early period after the establishment of certain fundamental principles of practice which may be termed routine procedures in the management of cerebral injury cases. Hospitals had been supplied with charts for the use of the internes and nurses, glucose solutions of various strengths were kept ready for instant use, hasty and useless X-ray examinations during the 12 hour period were eliminated, shock symptoms were recognized, and the early treatment for this distressing complication devised. These measures lowered the mortality, morbidity, and operative incidence. In the new King County Hospital (Harborview) had been organized a department of neurosurgery, equipped to offer the best immediate treatment for these cases. Our report for the first 45 cases treated (Table II) at the new hospital revealed a gross mortality of 35.5 per cent while 145 cases treated during 1930–1931 in 6 private hospitals in Seattle showed a gross mortality of 24.8 per cent. The difference between the two is accounted for by the fact that after Harborview was opened, most of the severe cerebrocranial injuries were sent there first and transferred to private hospitals after the immediate danger had passed.

In this study no effort was made to segregate the cases as to the location of the injury, as in our previous report, but we attempted to classify the cases as to "time elapse" and mortality figures. This was in line with other reports in large centers.

Treatment procedures were observed and recorded (Table III) in a series of 64 cases treated in private hospitals, as follows:

1. Rest only—ice bag and sedatives with a mortality of 21 per cent. These were, of course, the rather mild cases.

2. Rest and use of dehydration measures. Mortality dropped to 14 per cent.

TABLE I.—SUMMARY OF 178 HEAD INJURY CASES TREATED AT THE SEATTLE CITY HOSPITAL, 1919–1924

Region of fracture	Cases	Died	Mortality per cent
Frontal	46	29	63.2
Middle	42	22	52.8
Posterior	14	9	64.3
Basilar	76	48	63.2
Total	178	108	60.7
Operated upon	32	12	37.5

3. Operation before the use of dehydration measures with 50 per cent mortality.

4. Operation after the use of dehydration measures, 46 per cent mortality.

The gross mortality in the 64 cases was 26.5 per cent.

The gross mortality of 35.5 per cent in severe emergency cases at Harborview was a marked improvement over the 60.7 per cent at the old City Hospital (Table IV). Segregation into time periods rather than location of injury gave us a different angle from which to study our results.

In 1933 we reported on the first 175 cases treated at Harborview Hospital. These patients were admitted between March 1, 1931, and December 1, 1932, or in a period of 21 months; an increase of 300 per cent in the incidence of head injuries in a 10 year period. The gross mortality for these 175 cases was 22.4 per cent. For the first time, another careful check was made regarding ages, and we began to recognize a new factor and one which we will stress later (Table V). In Table V we have recorded the age incidence in 163 cases.

AGE AS A FACTOR IN INJURY AND MORTALITY

That age should be a factor in both the incidence and mortality of head injuries would, at first thought, not appear to be important, yet careful study reveals it to be a fact. The many "safety first" and "save the children" campaigns and traffic regulations have materially decreased the incidence of injury to children. Children also are seen to withstand severe head injuries better than adults, and the morbidity is never so high as in older patients. The gross mortality has remained about the same throughout. Rarely does one

TABLE II.—SUMMARY OF 190 SEVERE CASES OF CEREBROCRANIAL INJURIES: JANUARY, 1930—NOVEMBER, 1931

Hospitals	Cases	Physicians	Operations		Mortality							Improved cases			
					Total		Within 24 hours	Final mortality	Operative		Non-operative	Operations	Hospitalization Ave. No. days per case		
	Total No.	Total No.	Total No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	No.	Entire series	Non-operative	Operative
A	16	10	2	12.5	4	25.	2	14.3	0	0	4	2	15.4 days	13.9 days	23.5 days
B	27	11	6	22.	4	14.8	1	11.5	3 0 within 24 hrs.	50.	1	3	14.3	11.5	33.
C	44	31	15	34.1	12	27.3	8	11.1	5 3 within 24 hours	33.3	7	10	20.6	17.5	27.3
D	25	11	6	24.	7	28.	3	18.2	2 1 within 24 hours	33.3	5	4	17.5	20.2	7.3
E	24	16	5	20.8	8	33.3	3	23.8	4 1 within 24 hours	80.	4	1	8.5	7.7	20.
F	9	8	4	44.4	1	11.1	1	0	0	0	1	4	10.6	6.8	14.8
Total	145	85	38	26.2	36	24.8	18	14.2	14 5 within 24 hours	36.8	22	24	14.5	12.9	20.9
Harborview	45	4	2	4.4	16	35.5	12	12.1	1 0 within 24 hours	50	15	1	6	5.5	20.

TABLE III.—SUMMARY OF TREATMENT AND RESULTS OBTAINED FROM 64 CASES IN PRIVATE HOSPITALS, JANUARY, 1930—NOVEMBER, 1931

Treatment	Cases	Mortality					
				Deaths within 12 hours		Deaths after 12 hours	
	Total No.	Total No.	Per cent	No.	Cause	No.	Cause
Rest only, ice bag, sedatives	33	7	21	3	Shock	1 3	Shock (24 hours) Hemorrhage or edema
Rest with either glucose or spinal drainage, or both	14	2	14	1 1	Hemorrhage and shock Shock	0	
Operation only	4	2	50	1	Hemorrhage and shock	1	Hemorrhage or edema
Operation after glucose or spinal drainage, or both	13	6	46	2	Hemorrhage and shock	2 1 1	Hemorrhage or edema Abscess of lung Meningitis
Summary	64	17	26.5	4 4	Shock Hemorrhage and shock	1 1 1 6	Shock (24 hours) Abscess of lung Meningitis Hemorrhage or edema

have to resort either to surgery or to spinal drainage. In the age period above 60 years, one expects a high mortality because of complications of a general nature, senile changes elsewhere in the body, arteriosclerosis, nephritis, diabetes, and other general diseases.

The period of greatest incidence of injury was between the ages of 16 to 45 years. Almost half of the injuries occur in this period, and here we find the greatest morbidity and highest relative mortality. This study prompted us to keep a more constant record of the cases of an age period between 30 and 60 years. We began to recognize certain basic facts and to realize that a problem presented itself quite different from the cases of injury in patients under 16 years of age and over 60 years. Factors in middle age which play an

TABLE IV.—A COMPARISON OF THE FIRST AND SECOND REPORTS

	Cases	Mortality	Per cent
Seattle City Hospital 1918–1924	178	108	60.7
King County Hospital March–December, 1931	45	16	35.5

important rôle both as to the cause, and also as to the effect, of injury may include:

1. The activity of persons of this age in hazardous occupations.
2. The incipient stage of deterioration of the body mechanism.
3. The beginning of the slowing up process in mental reactions.
4. The effects of alcohol, hard labor, diseases and worry, which begin to show and to retard quick physical response to unusual demands.
5. The failure of repair processes or the retardation of response which add to the morbidity.
6. The disturbed water balance.

Of these factors, we believe that disturbed water balance is the most important.

CEREBRAL HYDRODYNAMICS

In 1928 I advocated the theory that the free water found in the ventricles and cisterns of the cranial cavity within and around the brain should be considered as reservoirs for the storage of water which is subject to instant demand on the part of the blood for use in the maintenance of blood volume. I also advocated that nature had contrived this mechanism as an ingenuous device situated in the most convenient place of the body for instant use, had protected it by a bony enclosure, and that it was subject to the natural physical laws of hydrodynamics.

As early as 1824, Kellie called attention to the importance of cerebrospinal fluid in maintaining blood volume. Burrows later added his belief that it had an important rôle beyond protection. Space does not permit a discussion of the details of our present conception, but the important factors bearing upon this problem may be mentioned and its relation to the reaction of patient to cerebral injury may be discussed.

TABLE V.—KING COUNTY HOSPITAL (HARBORVIEW) MARCH 1, 1931–DECEMBER 1, 1932 (21 MONTHS).

Ages*	Cases		Mortality		Mortality of age group of 175 cases	
	No.	%	No.	%	No.	%
1–16	37	22	5	13	5	28
16–45	70	42	13	35	13	7.4
45+	56	34	23	41	23	13.1
Total	163		41		41	

*12 cases unrecorded

The points which support at least the theory of a water reservoir are:

1. Location of water reservoirs within the bony enclosure of the craniovertebral cavity.
2. Distribution of water reservoirs both outside and within the cerebral hemispheres.
3. The presence of the enormously enlarged surface area of the choroidal plexuses, far more than the excretion of water alone would justify.
4. The intricate mechanical arrangement of the Pacchionian and arachnoid villi along the dural and spinal venous system for the rapid reabsorption of water into the venous channels.
5. The absence of water over vital surfaces and portions of the brain, such as the occipital and frontal lobes.
6. Physiologically one might mention the proved ebb and flow of cerebrospinal fluid volume in sleep and wakefulness, the decrease in sudden changes in blood volume as in hemorrhage with undoubted signs of cerebral anoxemia, hyperactivity during the menstrual period and sluggishness or stupor in hydrated states following heavy meals or drinking.
7. The demand for a variable to be present to act in any emergency, for the increase or decrease of blood volume is found ideally situated within the closed bony encasement of the craniospinal cavity subject to the laws of physics stated in the Monro-Kellie doctrine and later further elaborated and proved by Weed.

These are the points which must be considered in any study of the location and protection, purpose, and function of the cerebrospinal fluid.

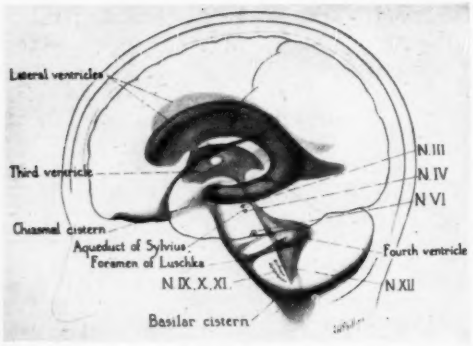

Fig. 1. Schematic drawing showing the relative size, shape, and distribution of the water within cerebral ventricles and the basilar cisterns. Note the funnel between the third and fourth ventricle (aqueduct of Sylvius). The location of the nucleus of the third, fourth, and sixth ocular nerves, and all of the ninth, tenth, eleventh, and twelfth cranial nerves is shown. Sudden pressure in the aqueduct may cause hemorrhages in the region of the ocular nuclei. Sudden pressure in the fourth ventricle may cause hemorrhages in the region of the ninth, tenth, eleventh, and twelfth nuclei, particularly the tenth. The outlet for the fluid from the chiasmal cistern is shown as a moderate constriction just at the lateral margin of the frontal lobe.

THE CEREBROSPINAL FLUID RESERVOIRS AND CEREBRAL INJURY

Too little emphasis has been attached to the water reservoirs in the cranial cavity and too great emphasis to the effect of the blood as "hemorrhage" in cerebral injuries. Our studies have shown us that the brain damage is most frequently the result of hydraulic pressure with resultant destruction of brain tissue rather than the result of hemorrhage. Hydraulic pressure within the brain causes injury whenever the flow of fluid meets with sudden resistance (Fig. 1). This occurs in injuries which cause the fluid within the lateral and third ventricle to be suddenly forced through the narrow aqueduct to the fourth ventricle. A mild blow may cause this and, as pointed out so clearly by Duret, unconsciousness may be followed by death in concussion with no gross findings of either brain injury or hemorrhage. These cases, however, all show the firm, shrunken brains of characteristic appearance of long continued edema of the arachnoid and traumatized tissues in certain definite areas.

A more severe injury will cause perceptible hemorrhages about the aqueduct and floor of the fourth ventricle, with accompanying respiratory and circulatory disturbances, as pointed out by Berner.

Another funnel-like opening is found between the chiasmal basilar cistern and the lateral cortico-arachnoid cisterns. Whenever the direction of force is from above, either direct or indirect, the fluid of the chiasmal cistern is forced through the narrow openings on either side and again similarly as in the aqueduct, the surrounding tissues are traumatized. In addition to this, however, the fluid on the under surface of both frontal lobes acts as an explosive force against these surfaces, and tremendous brain destruction occurs. Just as unconsciousness and low blood pressure and respiratory difficulty characterize the injury of tissues about the area of the aqueduct and fourth ventricle, so do certain clinical symptoms characterize trauma in the frontal areas. These are maniacal outbursts, ocular changes, visual and pupillary, and long continued mental disturbances. Post-traumatic psychoses are more commonly associated with lesions in which the damage is done by the basilar cistern in the middle fossa, while dizziness and disturbances to co-ordination and vision are frequent when the basilar cisterns and the fourth ventricle areas are involved.

Typical results of these explosive reactions are shown in Figure 2. It shows a typical injury to a brain, resulting from a fall of about 12 feet from a stairway to the pavement. The patient was intoxicated at the time, had been a heavy drinker, who suffered a severe compound frontal, basilar fracture. The effect upon the brain was both direct and indirect. The direct trauma caused the contusion about the upper surfaces of both frontal lobes (Fig. 2). Indirect trauma on the under surfaces of the frontal lobes show the effect of a bilateral basilar explosion, while a contrecoup contusion with hemorrhages appears about the occipital pole (Fig. 3). This is a typical injury resulting from hydraulic pressure suddenly exerted upon the under surfaces of the frontal lobes by the fluid in the anterior basilar cisterns.

May I call your attention to the second factor and one of the utmost importance in

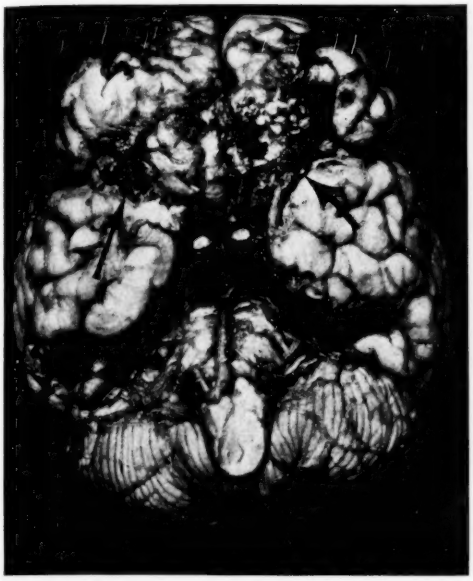

Fig. 2. Direct trauma, anterior tip of the right frontal lobe. Indirect trauma to the inferior surface of both frontal lobes.

this group of injuries—the convolutional atrophy (Figs. 4 A and B)? Figure 4 A shows the lateral surface of the brain in the case just presented—a chronic alcoholic; Figure 4 B the same view of the brain of an adult epileptic. An arteriosclerotic or syphilitic brain would present a similar picture. Grossly the four pathological conditions present identical physical problems—they all have hydrated or

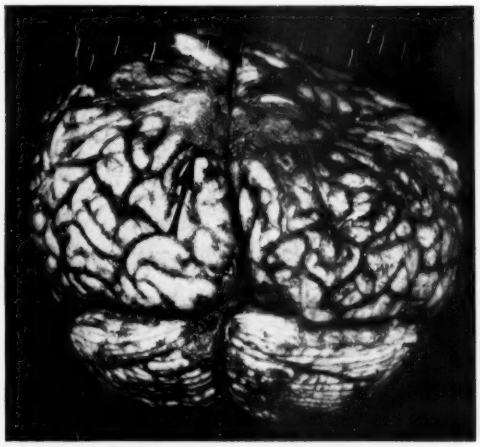

Fig. 3. Contrecoup trauma to the superior occipital lobes. Marked convolutional atrophy (chronic alcoholism).

"wet" brains—marked increase in the amount of subarachnoid fluid with consequent convolutional atrophy of the cerebral hemispheres. They, therefore, present a major problem in cerebral injuries. Since the hydrated, or wet, brain is more often present in persons after 40 years of age, it undoubtedly has a definite influence both on the incidence and subsequent mortality and morbidity of injuries occurring in this period.

With these facts in mind, we have made a final study of the cases treated at the King County Hospital (Harborview) during a period of 6 months, October, 1934, to April, 1935.

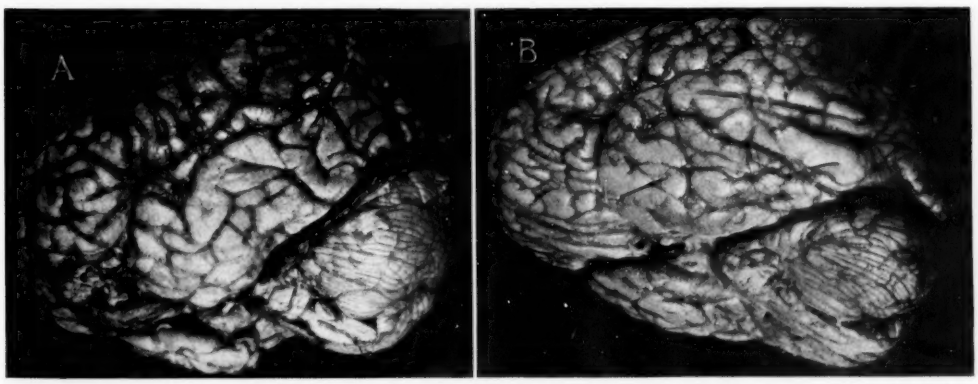

Fig. 4. A, Generalized convolutional atrophy (chronic alcoholism). B, Generalized convolutional atrophy (epilepsy).

TABLE VI.—INCIDENCE AND MORTALITY IN 214 CASES IN 5 YEAR PERIODS

Note the low mortality below 15 and after 60 but the high incidence and mortality between 15 and 60. The highest incidence between 40 and 60 years. King County Hospital (Harborview) October, 1934–April, 1935.

Classified as to Ages

Under	15	20	25	30	35	40	45	50	55	60	65	70	75	80
No. of cases	32	20	11	27	13	29	19	13	17	9	14	6	1	3
Died	3	6	0	2	2	7	4	3	4	2	3	2	0	2
Mortality—per cent	9.7	30		7.4	15	24	21	23	23	22	23	33		66

	1 to 15	15 to 40	40 to 60	60 to 80
No. of cases	32	33	78	71
Died	3	10	19	9
Mortality—per cent	9.7	30.3	24.4	12.6

Final mortality, 214 cases—Deaths 41—19.1 per cent mortality.

We have based our treatment of these cases upon the theory that:

1. The damage is largely done by direct hydraulic pressure and in direct proportion to the character of injury.

2. A disturbance to the normal cerebrohydrodynamics must be rectified at the earliest moment.

3. A maintained cerebrospinal fluid balance is essentially a determining factor both as to mortality and morbidity.

4. Cerebral hemorrhage, when fatal, occurs within the first 3 hours and in less severe cases may be controlled by proper spinal drainage.

5. The presence of a hydrated brain previous to the injury necessitates the most careful and constant observation.

6. The controlling factors are: blood pressure, pulse pressure, and sustained nourishment of the patient during these hours of repair.

7. Spinal drainage, hypertonic solutions, and whole blood transfusions are the most valuable procedures. They must be ordered only after careful evaluation of the demand for each one and under the constant supervision of trained nurses, internes, and surgeons. Our results are shown in Table VI.

TABLE VII.—CHART SHOWING THE INCREASE IN THE INCIDENCE AND THE DECREASE IN MORTALITY OF HEAD INJURY CASES IN SEATTLE OVER A PERIOD OF 16 YEARS

Period	Cases	Mortality per cent
1919–1924 (60 months)	178	60.7
March, 1931–December, 1932 (21 months)	175	23.3
October, 1934–March, 1935 (6 months)	214	19.1

From Table VI we may observe that the mortality in persons between the ages of 1 to 16 years is about the same as in our second report. In persons over 60 and especially over 70, the mortality depends largely upon the general health rather than the specific injury. If we are to lower the gross mortality, it therefore follows that we must improve our treatment in the group of persons between the ages of 40 to 60 years. In this group, we believe that the maintenance of water balance is a most important factor. A summary of our study is shown in Table VII.

CONCLUSION

In conclusion, may I again say, "cerebral lesions due to external violence challenge the surgeons of America to give immediate personal attention, to exert the utmost skill in diagnosis, to select proper personnel, to assist the hospital in its share of work, to train internes and nurses, to apply the laws of cerebrohydrodynamics, to prevent unnecessary sequelæ, to keep accurate records, and to publish the results." This is the challenge to the surgeons of America.

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THE DIAGNOSIS AND TREATMENT OF STONES IN THE COMMON BILE DUCT[1]

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DURING the last 20 years a radical change has taken place in the surgical treatment of biliary tract disease. Cholecystostomy with removal of stones within the gall bladder was the only operative procedure that the pioneers in modern surgery dared to undertake when dealing with this structure. Cholecystostomy gave relief to a considerable number of patients, but it soon became evident that too many of these patients had recurrent or continued symptoms, or were left with a persistent mucous or biliary fistula. With the improvement in surgical technique and with added knowledge concerning the character of the disease, the operation of cholecystectomy gradually supplanted simple drainage in the majority of instances. Cholecystectomy gave a higher percentage of cures and was on the whole a comparatively satisfactory procedure. Exploration of the biliary ducts for a long period of time was resorted to only in the presence of prolonged jaundice, or when a large stone could be palpated within the duct, or, secondarily, when symptoms persisted after cholecystectomy. Numerous surgeons were content to leave the ducts unexplored even in the presence of mild or moderate jaundice, in the hope that this feature of the process was due to a secondary inflammation about the outlet of the duct rather than to the presence of a stone within it.

Gradually, we have come to realize that there are numerous factors other than jaundice that must be taken into consideration regarding the ducts when biliary calculi are dealt with. When these factors are analyzed, it becomes evident that, in a large number of these patients, we may well overlook the more important pathological condition present by failing to explore the ducts. Reports by various authors from clinical experience and postmortem examinations place the percentage of stones within the common and hepatic ducts from 12 to 20 in all patients with gall-bladder stones. This percentage would indicate that, if we explore no ducts, we will fail to relieve a large number of patients. As a matter of fact, the signs of a probable pathological process within the ducts are frequently present even though careful exploration fails to reveal stones. Such stones may be high in the hepatic ducts or may be moved inadvertently to that position in which it is difficult to locate them and bring them down into position where removal is practicable. If the duct is not particularly abnormal pathologically, small stones may pass through the papilla of Vater after cholecystectomy, since it is known that the sphincteric action of the outlet is at least temporarily lost after the gall bladder has been removed. This probably accounts for the experience many of us have had, namely: a typical attack of biliary colic occurs after cholecystectomy and the patient has ultimate spontaneous relief. More often, however, these patients continue to have attacks of colic, and a secondary operation on the duct becomes necessary. The irritation brought about within the outlet of the duct by inflammation and the trauma caused by the stones passing through the papilla may result in a constriction of this rather narrow orifice, which in itself will impede the flow of bile. The result will be damage to the liver and a state of health incompatible with the ordinary activities of life.

INDICATIONS FOR EXPLORATION OF THE BILIARY DUCTS

Roughly the symptoms and signs which cause one to suspect a pathological condition within the common or hepatic ducts may be divided into two mains groups: (1) the pre-operative and (2) the operative. Among the pre-operative signs and symptoms are: (1) jaundice, active at time of examination or a part of the past picture; (2) continuation or recurrence of symptoms after biliary tract surgery; (3) chills and fever following epigastric pain; (4) frequent attacks of biliary colic;

[1]Presented before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

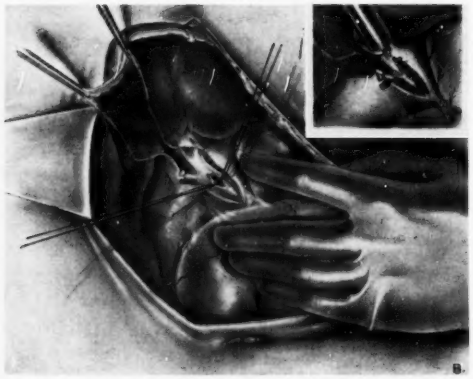

Fig. 1. Diagrammatic illustration of the exposure of the supraduodenal portion of the common duct with careful preservation of a border of the serous coat of the gall bladder and the areolar tissue overlying the ducts. The incision in the duct is held open with fine silk gut sutures. The lateral attachments of the duodenum may be freed as much as necessary for exposure. Inset A shows the diagnostic aspiration of the duct with a small hypodermic needle.

(5) severe nausea associated with attacks of typical pain; (6) gall stones found in the stools before operation. Among the operative signs and symptoms are: (1) small stones or sand within the gall bladder; (2) palpable stones within the ducts; (3) contracted gall bladder; (4) dilated cystic duct; (5) dilated common duct; (6) thickening in the head of the pancreas; (7) gall bladder without stones; (8) cholangitis.

Immediately we see that many of these factors so obviously indicate the necessity of exploration of the ducts that the average surgeon would not fail to realize that any operative procedure without this step would be unsuccessful. Also, it is apparent that several of these signs and symptoms may occur together in the same patient. It is only that we may not overlook some of the less common, less well known, or even less likely factors that they all must be considered.

Jaundice may occur coincidentally with gall-bladder stones, or, after the gall bladder has been removed. Even when pain has been present at the onset, jaundice may be present and still no stone may be found obstructing the duct outlet. In some cases the obstruction may be found to be due to stone and yet biliary colic is not present. The possibility of the presence of a malignant obstruction should be considered and the region investigated before the gall bladder is removed, as cholecystgastrostomy is a much easier and safer procedure than choledocho-enterostomy. However, in the vast majority of jaundiced patients with gall-bladder stones, we will find that the obstruction in the duct is due to the presence of a stone.

The continuation or recurrence of symptoms after biliary tract surgery is an embarrassing situation that few of us have escaped. It is true that, even when a diseased gall bladder has been removed and the ducts are found normal or when stones have been removed at the original operation, a few patients continue to be unrelieved. The burden of proof, however, is on the surgeon to find the source of the symptoms in overlooked disease of the duct. One must not be content with negative exploration as far as stones are concerned, as in a considerable number of these patients who have had many operations in this region, we find that the true situation is a constriction of the outlet of the duct. Rarely symptoms may be due to postoperative adhesions, a most difficult condition to evaluate and most unsatisfactory from the standpoint of treatment.

Biliary colic with very *frequent attacks* is one of the most often overlooked indications for exploring the common duct. The analysis of a large number of case records shows that this symptom is often due to the passage of small stones through the ducts, frequently due to disease of the duct alone, and occasionally due to a single ball valve stone within the duct even though no stone be present in the gall bladder. This warning may be of especial value in the patient with frequent attacks less than 1 week apart.

Nausea as a prominent symptom associated with biliary colic is an important indication of disease of the common duct. This has been demonstrated by Zollinger, who found that a collapsible bag inserted into the common duct under light anesthesia would, when the patient awakened, produce severe colic and nausea as soon as the bag was distended. Although this experiment was made on a comparatively small number of patients, the

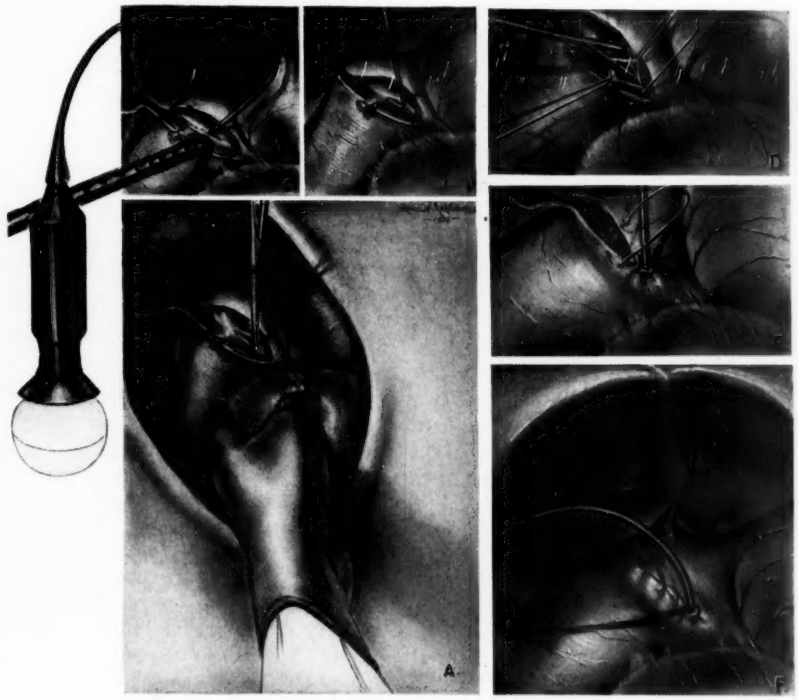

Fig. 2. A, Diagrammatic illustration demonstrating the method of palpation and exploration of the duct from the left side of the patient. Obvious stones removed with fenestrated forceps. B, The papilla is probed and dilated under palpation and partial vision. Care must be taken not to damage the incision in the duct by an incorrect instrument and too much force. C, The ducts are irrigated with normal salt solution in both directions. Importance of suction tip is emphasized. D, E, and F. A No. 10 soft rubber catheter is transfixed with a small atraumatic needle carrying No. 0 chromic catgut. These sutures fix the catheter within the duct, then are utilized to close loosely the opening in the duct and the areolar tissue over it. The border of the preserved serous coat of the gall bladder is then closed, a minimum of unperitonealized area being left.

symptoms coincide with the early history of many patients in whom common duct stones have been found at operation. Zollinger further demonstrated that distention of the gall bladder would give epigastric pain, but in none of his experiments did it produce nausea. Nausea may develop in the later stages of gall-bladder inflammation without duct stone as the ducts become secondarily involved. Also, this symptom may develop when the pancreas or duodenum become irritated, probably through the same nerve mechanism. However, the patient with early nausea associated with common duct obstruction often comes to the hospital for treatment after this symptom has subsided, and for the same reason nausea may not appear as an important factor in the data obtained.

Although the importance of the history and physical findings cannot be overemphasized, we are so often left with no real clew indicating disease of the duct that in nearly every instance we must consider the possibility of common duct involvement at operation. The only exceptions to this rule are represented by the extremely ill patient who submits to the life saving simple cholecystostomy and by those whose condition on the operating table

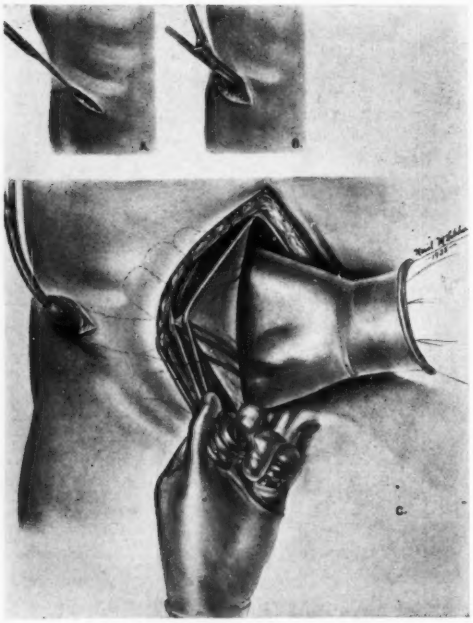

Fig. 3. Diagrammatic drawing showing the method of holding the peritoneum, fascia, and skin upward and toward the left side while the stab wound is made in the right flank.

precludes further prolongation of the operation after the gall bladder has been removed. The common duct should be partially exposed in the supraduodenal portion by dividing the areolar tissue over it (Fig. 1). Its size and inflammatory state must be determined. In many instances the duodenum will interfere with proper inspection and palpation of the duct region but it can be freed sufficiently without harm, whether the attachments laterally are normal or pathological. The foramen of Winslow should be exposed sufficiently so that palpation of the ducts can be made in a logical manner. In the average patient, the depth of this region makes palpation and inspection, as well as operative procedures on the ducts, much easier for the surgeon if he stands on the left side of the table (Fig. 2). Previously we described in detail the technique of operation on the common bile duct, and later we found that several resourceful surgeons had used this method of palpation of the duct region as a matter of course. Many others have told us since of their satisfaction in having adopted it. Stones within the duct that would elude the palpating fingers in the ordinary examination, are easily detected if this method is used.

Small stones and sand represent the most common finding in the gall bladder that makes common duct exploration logical. That these small particles have found their way through the cystic duct is almost certain. To be sure, they may have passed on through the papilla of Vater into the duodenum. At operation we often find, however, that many of these particles are still within the ducts. It is too much to hope or expect that they will always be discharged spontaneously. With careful technique, the duct can be cleared of this débris with perfect safety. If the papilla is dilated, there is opportunity for a free flow of bile into the intestine, carrying with it unreachable stones and nuclei for future calculi of sufficient importance to eliminate the necessity of a secondary operation.

When we encounter a *contracted gall bladder*, we usually have a patient with a long history of difficulty in this region. Doubtless, when this condition is found incidentally, it represents nature's method of cure. Many such patients with long remissions may finish out their lives without sufficient trouble to warrant surgical interference. Often, however, difficulty develops within the dilated common duct, which represents the location of the active lesion, rather than in the gall bladder itself. At times, it is wise to ignore the original process as represented by the contracted gall bladder and to correct only the pathological process in common duct. Usually there are stones within the duct. Occasionally, however, the true condition is a constriction of the duct outlet, proximal to which is found inspissated bile, thickened duct walls, and liver damage. It is important not only to free the ducts of stones and débris but to provide for a normal flow of bile. If the decompression of the liver can be accomplished in such a manner as to allow drainage to take place into its normal habitat rather than to the outside, we will hasten the recovery of the patient and avoid prolonged external drainage which increases hospital stay and invalidism.

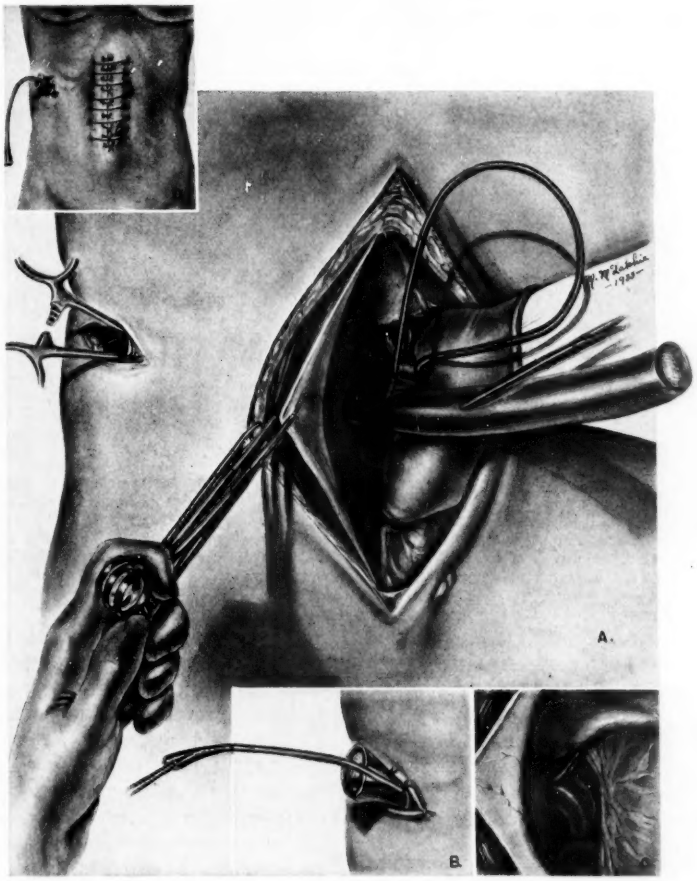

Fig. 4. Schematic drawing illustrating the method of bringing the catheter and cigarette wick through the stab wound under direct vision, the duodenum and hepatic flexure being protected by omentum. The catheter lies along the underneath surface of the right lobe of the liver and the cigarette wick is carefully placed in the subhepatic space of Morrison.

Dilated ducts found at operation indicate as a rule disease within them. If the cystic duct is large and patent in the presence of gall stones, we must assume that some and rarely all of these stones have passed into the common duct. This often occurs in the absence of jaundice. Although we frequently fail to find stones within the common or hepatic ducts, we do find them in a high percentage of such cases. The average diameter of the normal common duct is approximately 5 millimeters. When we find that this duct is larger than normal, we must assume that the abnormality may be due to disease within it. That the common duct increases in size after cholecystectomy is well known. This abnormal state may be reproduced through interference with the physiological mechanism by inflammation, by pressure from stone, etc. in patients without previous operation. The dilatation in many instances, however, is apt to be due to mechanical obstruction of the duct outlet. Doubtless these various factors are often combined to bring about the increase

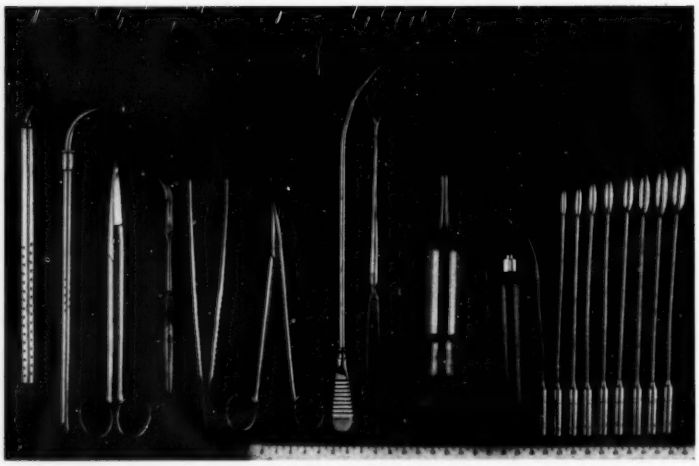

Fig. 5. Photograph of instruments found useful in common duct surgery. A small size suction tip has been fitted with a hollow ground trocar point, useful in aspirating a tense gall bladder. The long curved scissors and fine tooth forceps are helpful in dissection. The small curved knife is the safest instrument to use in opening the duct. To the right are shown American made dilators after the Bakeś model. The bulbs run from 3 millimeters to 11 millimeters in diameter.

in the duct capacity. Since it is impossible to know whether stones or a constricted outlet are present, we must explore these dilated common ducts routinely.

We so frequently find a definite *thickening in the head of the pancreas* associated with gall-bladder calculi, that we cannot help but feel the significance of relationship between those two systems. The frequency with which gall stones are noted in the presence of acute hemorrhagic pancreatitis makes it difficult to dissociate the biliary system as an important factor in pancreatic disease. For this reason, we have included in our gall-bladder statistics all cases of acute pancreatitis found at operation when the operative procedure included drainage of the biliary system. When the pancreas is felt to be thickened, we look for fat necrosis, particularly in the underneath portion of the gastrocolic omentum. In the majority of cases, we find none. Rarely do acute manifestations of pancreatitis develop after the biliary tract has been explored. Often, however, in the presence of pancreatic enlargement, we find a dilatation or a thickening of the duct wall, and occasionally a true inflammation within the ducts. Stones or débris in the ampulla of Vater or a constriction of the outlet are so frequently associated with this pancreatic thickening, that we feel justified in recommending exploration of the ducts in all such cases.

By the term "*gall bladder without stones*," we refer to the type of patient whose symptoms indicate biliary tract disease, and who exhibits at operation little abnormality in the gall bladder itself. Many of these patients with a positive Graham test will fail to show, at operation, a gross pathological condition, particularly stones. We have long been unhappy concerning the necessity of a microscopic diagnosis in cholecystitis. Even when gross cholesterolosis is found, the removal of such a gall bladder, in many instances, has failed to relieve the patient of symptoms for which the operation was undertaken. Recently, Graham and Mackay have shown that the highest percentage of unrelieved patients in gall-bladder surgery were those with minimal disease. Although we can avoid surgery in many of these cases by a more careful regulation of diet and by an evaluation of the functional elements concerned in neurotic individuals, we will of necessity, operate upon some

such patients. When a comparatively normal, stone free gall bladder is found under these circumstances, there may be a single ball valve stone within the common duct, or even rarely, several stones, without any apparent increase in the size of the duct or any actual thickening in the duct wall itself.

Cholangitis varies so much in the condition found at operation, that often we are unable to remedy the situation by one procedure. The ducts that are constricted, thickened, and full of débris are particularly difficult to explore and failure results. Later the ducts may become dilated so that proper dilatation of the outlet and proper drainage permit a good recovery. If the ducts are sufficiently large to permit exploration and drainage with dilatation of the papilla at the primary operation, the results are apt to be satisfactory. It is believed that the earlier the operation in suspected cholangitis, the greater the possibility of a successful primary procedure.

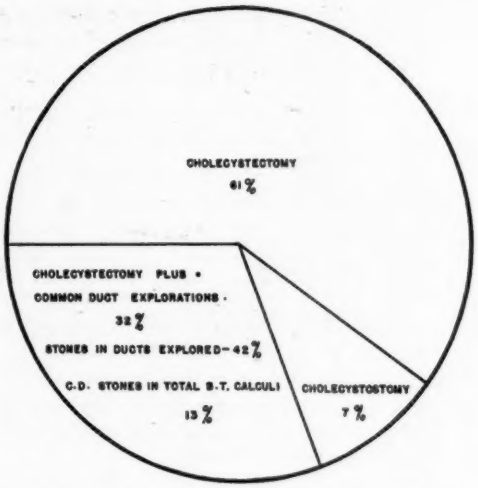

Fig. 6. Biliary tract operations, Massachusetts General Hospital, October 1, 1930–October 1, 1935.

TECHNIQUE OF OPERATION

With the increasing consciousness of common duct stones associated with gall-bladder disease, it becomes imperative to develop a safe and satisfactory technique of duct exploration. To avoid overlooking stones, the surgeon must necessarily open many more ducts than are found actually to contain stones; hence the surgeon must work out a plan by which he can explore the ducts and yet not damage them or increase the mortality rate. An easy, simple, and safe procedure has been described in detail (2): It consists in exposing the duct in its supraduodenal portion; palpating it carefully from the left side of the patient; removing stones with the fenestrated forceps; probing the hepatic ducts and the papilla of Vater, then gradually dilating the papilla after the method of Bakeś to a diameter just below that of the duct itself, or sufficiently to allow stones of the size present to pass through, if they have been overlooked or have become lodged within the hepatic ducts. The ducts are then irrigated with normal salt solution and a No. 10 F. catheter is sutured in the incision in the duct and is led to the outside with a cigarette wick. The wick is placed in the subhepatic space of Morrison where all drainage from this region collects. The wick and catheter are brought out through a stab wound below the twelfth rib. This allows complete closure of the abdominal wound and when done under vision and with care is a rational procedure. In a large series of patients so treated, we have had no complications from this procedure or cause to regret this type of drainage. It shortens the hospital stay and decreases the number of infected wounds and incisional hernias.

Routine dilatation of the papilla of Vater when the common duct is explored was first brought to our attention by Cheever. He used for this purpose silk woven catheters, the sizes varying from a No. 10 to No. 20 F. He found that the normal papilla would admit the No. 10 size and that gradual dilatation could be carried out in almost all instances up to a No. 20, without apparent damage to the tissue. This commendable method allows irrigation through the dilating instrument—a step the value of which is enhanced by the flexibility and shape of the tip. We have used this method with considerable satisfaction for several years. Its disadvantages we found were chiefly that the larger sizes were unwieldy and that sterilization of the catheters

TABLE I.—BILIARY TRACT OPERATIONS

1931–1934, Inclusive, at Massachusetts General Hospital

	1931		1932		1933		1934	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Total operations for biliary stone	215		231		272		242	
Common ducts explored	45	21	68	30	93	34	92	38
Common duct stones recorded	19		30		37		34	
In ducts explored		42		44		40		37
In all gall-bladder operations		9		13		14		14

was difficult. The catheters also are expensive and short lived, and when they become roughened with use may damage the tissues through which they pass. Cheever, however, and many of his pupils have had no fault to find with the method over a period of several years. Many surgeons having realized the importance of dilatation of the papilla in selected cases have used a variety of urethral sounds and bougies for the purpose. The long, olive tip bougies with bendable shafts proposed by J. Bakeś, of Bruenn, Czecho-Slovakia, are very satisfactory. We have used them in more than 231 instances in our hospital since they were brought to our attention in 1930 by Dr. Richard Chute. The sizes are graduated from a diameter of 3 millimeters to that of 14 millimeters. Although Bakeś always advocated dilating the outlet of the duct to a size just below that of the duct itself, we have rarely used the larger sizes. We do think it important to dilate the papilla to a sufficient size to allow stones lodged in the hepatic ducts to pass after operation, and have collected stones in the stools in a few such instances. We have opened the duodenum over the papilla in 7 cases when the probe or small dilator failed to go through from above with ease. In these patients and in experiments on dogs, we have been impressed by the minimal damage to the tissues through which these dilators pass. It is probable that, in certain cases with large ducts, a constricted outlet, and a damaged liver, better results will be obtained if the outlet is dilated to a considerable size, even up to 1 centimeter or more. The outlet is likely to remain dilated indefinitely, and the bile will then be delivered directly into the intestine. We are sure that this will eliminate prolonged T-tube drainage to the outside in certain cases in which a protracted period of drainage is desired. We feel, however, that in the routine case, an average dilatation up to 7 millimeters will suffice. We urge that gentleness and care be taken to direct the probes properly under palpation and under vision. If undue force is necessary, we believe it safer to open the duodenum and begin the dilatation in a retrograde fashion. Under no circumstances should dilators as large or larger than the diameter of the duct itself be used, since it is not our purpose to stretch the walls of the supraduodenal portion of the duct, but simply to dilate the outlet.

All thoughtful surgeons admit the importance of, and most of them practice, the procedure of ascertaining in some manner the patency of the papilla of Vater when the common duct is opened. Without doubt, in the majority of cases, this alone will suffice. We have been impressed, however, with the uncertainty of clearing the hepatic ducts of stones or débris. Also, we believe that the frequency of finding a constriction of the duct outlet justifies dilatation of the papilla in a safe manner and to a suitable degree routinely when we explore the ducts. That this is not a dangerous procedure is borne out by our statistics. Although it appears that the mortality is lower if in duct exploration the papilla is dilated than when it is not (Table II), we believe that this apparent discrepancy may be due to other factors. We are sure that in the hands of a good many operators from chief surgeons to resident staff, even when reasonable care is used, ample opportunity is offered for serious difficulty with the method if it were dangerous.

TABLE II.—TOTAL BILIARY TRACT OPERATIONS

Massachusetts General Hospital—October 1, 1930—October 1, 1935

	Cases		Deaths		Percentage of mortality	
Cholecystostomy	82		12		14.5	
Cholecystectomy[1]	751		22		2.9	
Cholecystectomy with common duct exploration and dilatation of sphincter[1]	231	395	9	17	3.9	4.4
Cholecystectomy with common duct exploration and sphincter not dilated[1]	164		8		4.9	
Total (5 years)	1228		51		4.2	

[1]Under the headings "Cholecystectomy with common duct exploration" are included several cases of secondary choledochostomy; the gall bladder having been removed at a previous operation.

External drainage of the common duct has been the practice of choice although a few surgeons have advocated internal drainage through the papilla. The reasons for outside drainage temporarily, in addition to dilatation of the duct outlet, are that we are certain that tight closure of the duct incision is difficult to obtain and a temporary reaction with swelling at the papilla after dilatation may exist. It is likely that the hydraulic action in a tightly closed duct would be more effective in discharging stones overlooked, but this is offset by the advantages of taking the pressure off the duct suture line as well as of relieving the liver of any temporary resistance to the flow of bile. If drainage from the abdominal cavity alone is depended on to take care of the bile that escapes from the incision in the duct, the bile is delivered into the abdomen faster than the drains can accept it; thus causing bile peritonitis, which, although rarely fatal, in all cases, retards convalescence. In no instance have we had cause to regret the use of the small catheter in the duct, which drains approximately 400 cubic centimeters daily or about one-fourth of the average daily secretion of the liver. It gives us some indication of the activity of the liver, and in rare instances, valuable information concerning the patency of the duct outlet. This catheter is sutured with No. 0 chromic catgut into the duct and removed with the wick on the tenth or twelfth day. The stab drainage wound is dry by the fifteenth day, and in no instance have we had to re-establish drainage in the sinus.

TABLE III.—CAUSES OF DEATHS IN BILIARY TRACT OPERATIONS

Massachusetts General Hospital—October 1, 1930—October 1, 1935

	Cases		Cases
Pneumonia	12	Shock	1
Pulmonary emboli	9	Subdiaphragmatic abscess with rupture into pericardium	1
Peritonitis	9		
Pancreatitis	7	Cholangitis	1
Hemorrhage	5	Bilateral pulmonary collapse	1
Bile peritonitis	2		
Liver death	1	Pulmonary edema	1
Myocardial failure	1		

POSSIBLE COMPLICATIONS FROM DILATATION OF THE PAPILLA

The dangers that might arise in the routine instrumental dilatation of the papilla of Vater when the common duct is explored materially have occurred to us. We approached the method with great caution thinking particularly of the possibility of duodenal reflux. In only one instance has this occurred, and that we feel sure was due either to a false passage of the catheter into the duodenum or to the placement of the catheter through the dilated papilla into the duodenum. Duodenal contents came through the catheter while bile was delivered through the cigarette wick. This patient made a good recovery and all drainage ceased on the twenty-first day. One of the other dangers we considered, was cicatricial constriction of the dilated duct outlet. We have seen no evidence of this condition in the 231 cases so treated. So far, 2 patients have returned for secondary operations.

CASE 1. A patient who had a cholecystectomy for gall stones and stones removed from a dilated common duct with dilatation of the outlet to 1 centimeter in the presence of jaundice, returned 3½ years later with jaundice following colic. At the second operation a large stone was removed from the ampulla of Vater, after which the 8 millimeter dilator passed into the duodenum with ease.

This indicates that stones may form in the common duct in spite of a dilated outlet.

CASE 2. The other patient was operated upon in October, 1934, after a 6 weeks' history of pain, jaundice, and chills. His gall bladder was thick walled and chronically inflamed but contained no stones. It was removed and a large duct was explored but no stones found. The outlet was found constricted and was dilated to 9 millimeters. This patient drained

an abnormal amount of bile through his catheter, the amount reaching 2,500 cubic centimeters in one 24 hour period. After the catheter was removed on the tenth day, he had a severe attack of colic, which we interpreted as due to the passage of an overlooked calculus. He made a rapid recovery afterward, but several months later began having a return of symptoms and finally became jaundiced. He naturally was hesitant about a second operation but after a severe intestinal hemorrhage, he finally returned to the hospital. At operation this time, the duct was found dilated and much thickened and no instrument would pass through the outlet. His condition did not permit further maneuvers at the time, so the duct and abdominal wounds were drained. A reasonable amount of very thin bile was obtained daily administered in the form of cocktails or through a nasal tube for several days. In spite of this, his appetite failed, and his condition became precarious with low blood chlorides and low serum protein, associated with a rising non-protein nitrogen. A jejunostomy was performed to permit feeding, 19 days after the choledochostomy. Since this procedure, he has gradually gained in strength and the character of the bile draining from the sinus has improved. His appetite has returned so that the jejunostomy is now used for the replacement of bile only. We believe that he will gain sufficiently to permit a future operation to re-establish the bile drainage into his duodenum.

There has been only one other possible complication following dilatation of the papilla. In this case, the operator stated that there was no evidence of pancreatitis at the time of cholecystectomy and exploration of the duct. The outlet was dilated to 8 millimeters in the presence of a dilated duct from which stones had been removed. The patient developed acute hemorrhagic pancreatitis from which she died 3 weeks later. Whether the dilatation played a rôle in the pancreatitis is a matter of conjecture, but it must be considered as a possibility. Recently, however, we have purposely dilated the papilla in the presence of fat necrosis; recovery was comparable to that after routine cholecystectomy and far more quickly than the average in the presence of acute pancreatitis. It is only fair to state that Lahey has recently reported 2 cases of fatal gas bacillus infection following the instrumental dilatation of the papilla of Vater. We do not believe that this unfortunate complication was brought about by the dilatation. We all know that the gas bacillus may be found in the gastro-intestinal tract or even in the gall bladder itself. Fortunately, this type of contamination is rare and none of us hesitate, when necessary, to open the duodenum or jejunum in a comparatively unaseptic manner.

STATISTICAL DATA

In the 5 year period from October, 1930, to October, 1935, 1,228 patients with biliary tract disease have been operated upon at the Massachusetts General Hospital. Of these, 395, or 32 per cent, have had the ducts explored. Stones removed from the ducts were recorded in 167 patients, representing 42.2 per cent of the ducts explored and 13.6 per cent of the total operations. Fifty-one patients died, a mortality in the whole group of 4.15 per cent. In the 395 who had duct explorations, 17 died, a mortality of 4.4 per cent. When we consider that the highest mortality (Table II), occurred in those patients considered too ill to have more than cholecystostomy done, it may seem to offset the apparent lack of increased danger in duct exploration as compared to the mortality of 2.9 per cent in simple cholecystectomy. We must consider, however, that the duct explorations included many secondary operations (61 cases) and also the very poor risk patients with prolonged jaundice. On the whole, we feel justified in stating that choledochostomy superimposed upon cholecystectomy, if carefully carried out, increases the risk slightly, if at all. One hundred forty-five, or 42 per cent, of the duct operations were in patients without history of jaundice. In this group, stones were recorded in 49, or 34 per cent. A history of frequent attacks was given in 273 cases; 223 had enlarged ducts; 98 had chills and fever; 61 had had previous biliary tract surgery; and 46 had pancreatic disease.

SUMMARY

1. We urge that common duct exploration be carried out in primary operations on the biliary system when the history or operative findings suggest the possibility of stone within the ducts, or a constriction of the duct outlet.

2. We feel that routine instrumental dilatation of the papilla of Vater is not only a logical, but a safe, procedure in all ducts explored.

3. We advocate temporary drainage of the bile duct to the outside and drainage of the abdominal cavity.

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Discussion

DR. STANLEY H. MENTZER, San Francisco. The wisdom of exploring the common duct more frequently during the course of operations upon the gall bladder is shown admirably by Dr. Allen. Past experience and present practices have justified the slightly increased risks that this new treatment entails, for the end-results are better and re-operations are less frequent.

Dr. Allen repeatedly urges that care and gentleness be maintained during the dilatations of the sphincter of Oddi. Those who have seen the esophagus, ureter, and rectum split by similar mechanical dilators, appreciate the necessity for care and they will respect the teachings of the author. But the surgeon less experienced in the necropsy room may not be cautioned by his past training. Under these circumstances, the dilatations advocated by Dr. Allen are fraught with potential harm. The sizes of the larger dilators are enormous in respect to the anatomy of the normal common duct. When the common duct is dilated and the largest bougies used, the elastic and muscle tissue of the ampulla of Vater is already stretched, and the danger of rupture of these attenuated structures is therefore increased. Although Dr. Allen and his associates have not had any complications from the use of this method, it behooves those of us who are less experienced, or not experienced at all, to approach this technique with delicate fingers and tender consideration for pathological tissue.

ISCHEMIC CONTRACTURE[1]

ARTHUR STEINDLER, M.D., F.A.C.S., Iowa City, Iowa

IN the ill repute which fracture of the elbow enjoys among the medical profession, the ischemic contracture has its full share as one of the dreaded complications. Volkmann, after whom the contracture is named, considered it a postmortem rigidity of the muscles, strictly due to arterial ischemia and to the complete shutting off of oxygen supply. It was Bardenheuer who later pointed out the importance of the venous backflow, stating that the deep venous system, richly supplied with valves, has ample communication with the subcutaneous network in the elbow fold by means of an avalvular system of anastomosis which permits the emptying of the deep veins into the superficial ones. This emptying is impeded as the pressure is raised in the layers with a resulting excessive carbon dioxide accumulation in the vein. The endothelial wall becomes damaged and permeation of plasma into the muscles takes place, which finally leads to the well known pathological changes. Defined from the purely pathological point of view, ischemic contracture is a fibrous retraction of the muscles of the forearm.

Investigators acutely interested in the causation of this severe interstitial myositis have tried to solve the problem from the clinical as well as from the experimental angle. Is it the shutting off of the blood supply by injury or rupture of the brachial artery; or is it due to the subfascial pressure impeding the venous backflow; is it caused by involvement of the peripheral nerves, or is it the result of sympathetic nerve lesion leading to vasomotor disturbances?

ARTERIAL OCCLUSION

There is accumulative evidence that arterial occlusion may lead to ischemic contracture. Jones recently reports a number of cases in which the brachial artery was either hooked over the end of the proximal fragment or caught in the fragment; where the radial artery was torn; where a thrombus obliterated the artery; and finally, where the artery was occluded by fascial pressure. That ischemic contracture follows immediately upon cessation of the arterial blood supply was also proved by an experiment on a patient, of temporarily clamping the brachial artery.

Leriche also called attention to the frequent occlusion of the trunk of the arteries in Volkmann's contracture, and Lance, in 1933, reports a case of complete obliteration treated with humeral or with brachial arteriectomy. The artery is found completely obliterated by proliferating endarteritis. There is no indication of a primary arterial thrombus, but rather a leucocytic infiltration of the media indicating an inflammatory and proliferating process. The arterial occlusion leads to necrotization of the muscles and, peculiarly enough, is limited to the flexors and pronators of the forearm.

On the other hand, similar clinical observations are made in venous stasis. Brooks, examining the effects of acute venous obstruction, found swelling, muscle paralysis, and blood extravasation into the muscle with polynuclear infiltration and proliferation of the connective tissue.

So far as significance of primary nerve involvement is concerned, opinions are divided. Some observers maintain that the integrity of the peripheral nerve supply is essential for the contracture; they find that, after resection of the posterior roots and plaster fixation, the contracture developed slowly and more as a muscle contraction; whereas without resection of the posterior roots, rapid contracture developed. This would indicate, according to Meyer and Spiegel, that for the ischemic contracture, the fixation reflex is necessary, the reflex being the primary condition and the muscular contracture the effect.

As a matter of fact, the direct injury to the nerve frequently does occur, but it has not been proved as yet that such injury is the primary cause of the ischemic contracture (Jepson). On the other hand, it is claimed

[1]Presented before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

that the constriction lasting for a long time, sufficient to close the larger blood vessels of the brachial region, must exert a strong pressure upon the median and ulnar nerves, causing neuritis and degeneration. The musculospiral nerve is too deeply placed and too well protected, but the median nerve and in particular the ulnar nerve are frequently involved. Again, Leriche and his followers attribute great significance to the irritation of sympathetic nerve supply of the vessels, resulting in peripheral vasoconstriction.

In view of these discrepant clinical observations, it should be interesting to review shortly the results of experimentation on the pathogenesis of this contracture.

THE EFFECT OF ARTERIAL ISCHEMIA

Meyerding, in 1930, stated that in animals contracture is not produced by the ligation of the artery alone. Thrombosis and ligation in either upper or lower extremity results in flaccid paralysis with or without gangrene, according to Raffele and Jepson.

Stenson ligated the abdominal aorta and likewise obtained flaccid paralysis. In a case of our own experience where the femoral artery was ligated for uncontrollable bleeding in a child suffering from osteomyelitis, the result was also permanent flaccid paralysis but no contracture. The accompanying sensory paralysis at first complete, gradually receded, but no contracture developed. Similarly, the ligation of the external iliac and epigastric, carried out by Lapinski, produced coldness, flaccid paralysis and disappearance of reflex excitability, but no contracture and no muscular rigidity, although histological examination showed changes in muscles and nerves, particularly in the latter, in the form of fragmentation and degeneration.

Brooks, in 1925, observed that ligation of the artery alone did not produce total paralysis, and in some instances he could demonstrate fields of totally viable and others of totally necrotic muscle adjacent to each other.

THE EFFECT OF BOTH ARTERIAL AND VENOUS OBSTRUCTION

Experiments in which arterial ischemia was used with venous stasis by ligating femoral artery and vein showed contraction phenomena, but these also were transitory; although when ligation was sufficiently high, for instance at the common iliac, gangrene resulted.

THE EFFECT OF VENOUS STASIS ALONE

Jepson produced in animals a claw hand contracture by applying a rubber bandage, but this contracture disappeared within 3 to 4 hours after the tourniquet was removed. When the femoral vein was ligated, the extremity became cold and bleached and flaccid, and soon went into a claw deformity, the deformity persisting from 6 to 9 days. On the other hand, Raffele, after ligating the femoral vein, was not successful in producing a true ischemic contracture.

On the whole, the most definite experimental results were obtained where constriction was combined with fixation after fracture of the limb (Raffele). The circulatory disturbance was accompanied by flexion rigidity and then by contracture which approached the ischemic type. In this he probably approached closest the actual clinical condition, since there was added a hematoma in the subfascial space of the forearm with diffusion of blood and the subsequent organization.

In view of the fact that Volkmann, and in fact others, maintain that the circulatory obstruction is responsible for this deformity, it is interesting to note the difficulties with which ischemic contracture is produced experimentally. In fact, Serra goes so far as to say that in the light of experimental investigations the plaster cast is almost completely exonerated, a statement which, I believe, is somewhat overdrawn.

Our own statistics, based on 50 cases, show that casts were applied in 18 cases; splints were applied in 18 cases; the Velpeau bandage in 8 cases; the acute angle or right angle position was assumed in 26 cases; position not stated but presumably right or acute angle, 30 cases. No immobilization was applied in 4 cases. Since among the total number, only 18 patients were treated by plaster cast, one may wonder whether in general the plaster bandage can be accorded a prominent rôle in the production of ischemic contracture. While a constricting dressing may easily accentuate

the effect of the trauma by preventing the establishment of collateral circulation, it certainly cannot unconditionally be held responsible for the development of this deformity. On the other hand, the cast or bandage can be a very definite contributory cause, and for this reason, careful supervision and general vigilance are essential features in the treatment of this fracture. But, I believe, there are other factors of even greater importance in regard to medical responsibility.

PREMONITORY SIGNS AND THEIR SEQUENCE

In general, one may state that the sequence is coldness, cyanosis, swelling, paresthesia, pain, flaccid paralysis, contracture of the flexor muscles and, finally, the development of the claw hand, *main en griffe*. But there is a considerable difference in the rapidity in which the events follow each other, also in the time of latency, and finally in the intervals between the first premonitory symptoms and the development of definite objective symptoms. In our own series acute premonitory symptoms were observed in 35 cases; in 10 of these immediately, in 8 within the first week, in 10 after the first week, in 7 cases later. In 15 cases no data of acute signs such as cyanosis, numbness, or paresthesia were given.

In 20 cases in which definite statements of acute symptoms and their time of onset were at hand, the timely removal of the dressing, that is at the first appearance of the symptoms, was recorded 6 times; while the late removal of the dressing, after an undue interval following the acute premonitory symptoms, was recorded in another 14 cases. Among 15 cases, on the other hand, in which no acute symptoms occurred, timely removal of the dressing, that is upon the first sign of contracture, was recorded in 10 cases and delayed removal in only 5. In 7 cases the contracture developed while the cast was being worn, while in the majority the contracture did not appear until after removal of the cast.

It would appear from this short analysis that if any accountability exists, its particular burden lies in the failure to pay proper attention to the first premonitory signs and not so much in recognizing the actual beginning of the contracture.

PATHOLOGY

Corresponding to these two clinical stages the acute premonitory signs and the chronic development of contracture, there can be distinguished two pathological phases: The first is characterized by edema, cyanosis, the waterlogging of the perimysium of the muscles, the infiltration and accumulation of leucocytes in the interfibrillary spaces, loss of the nuclei of the sarcolemma, loss of transverse and longitudinal striation, the irregularity of contour, undulation and, finally, the defibrillation and separation of the individual muscle fibers ("myolysis," Marenesco), leading to atrophy and fragmentation of the muscle fibers. The muscle degeneration is of the granular type; there is no fatty degeneration and there is also no intermuscular hemorrhage.

In the second stage there is a gradual absorption and destruction of the disintegrated muscle fibers. Raffele calls attention to special cells arranged circularly around the muscle fibers, particularly near the vessels, in immediate contact with the muscle fibers. They penetrate the fibers and absorb their contents. They are histolytic cells of local origin with purely phagocytic function. One can also see pigmentation and round cell infiltration of the muscle fibrillæ. It finally comes to a substitution of the destroyed muscle fibers by fibrous tissue from the surrounding connective tissue elements. Peculiarly enough, the pathological changes are rather unequally distributed, and one finds some portions of normal or almost normal muscle elements preserved while others have completely succumbed to fibrosis.

Vessels and nerves are found embedded and constricted in fibrous masses. Myositis ossificans in ischemic contracture is described by Nitsche as probably due to the hematoma which, poorly absorbed, produced not only connective tissue proliferation but was also responsible for the ossification which occurred 4 months after the injury.

THE CLINICAL PATHOLOGY OF THE CONTRACTURE

Acute stage. The acute prodromal symptoms last only 1 to 2 weeks and they are in sequence: edema, cyanosis, pain, paresthesia,

hypesthesia, motor paralysis, and trophic disturbances. Among our 50 cases we found numbness as initial symptom in 26 cases; edema in 12 cases; cyanosis in 5 cases; trophic disturbances in 12 cases.

Permanent stage: The muscles first become flaccid, then there is muscle rigidity, and, according to Jepson, after 65 to 70 hours, the muscle is again flaccid and tender to pressure. After 2 weeks, the swelling disappears and the formation of the contracture begins.

Of interest is the almost exclusive localization of the contracture in the flexor and pronator groups of the forearm. This is explained by Soubeyran (1922) by the peculiar anatomy of the arterial system of the arm; the circulation stopping at the ventral part but being secured dorsally by numerous anastomoses. The contracture is a combination of flexion of the mid-phalanx and end-phalanx with flexion of the wrist. To this is added the extension contracture of the metacarpophalangeal joints and the pronation contracture of the forearm. Although this is the most frequent type of contracture, it is by no means the only one. In many cases, the hyperextension contracture of the metacarpophalangeal joints is missing, and others only show a flexion contracture of the wrist similar to that seen in musculospiral palsy. The abduction of the thumb is another feature. The thumb is held in the plane of the fingers, having lost its power of opposition and pronation against the palm. It is often associated with strong flexion of the end-phalanx of the thumb due to contraction of the long flexor. In the fully developed claw hand contracture, the pathological sequence of contracture can be readily understood. First, there appears the flexion of the finger joints, then follows the flexion of the wrist, and later follows the extension contracture of the metacarpophalangeal articulation with retraction of the knuckles. The hyperextension of the metacarpophalangeal articulation is largely the result of the passive insufficiency of the extensor group, but does not necessarily indicate that there is loss of action of the interosseous muscles.

It is somewhat different if there is a secondary peripheral nerve involvement. Then the claw hand deformity becomes somewhat modified, depending upon the contributory effect of the nerve lesion. If there is ulnar nerve involvement, the claw hand formation becomes much more accentuated.

Sensory lesions. We found sensory lesions, on the whole, rather frequent complications, but in the majority of these cases the disturbances are not anatomically defined, as one would expect when a peripheral nerve trunk is injured. There is, as a rule, an area of hypesthesia with a hyperesthetic border, but it is not uncommon to see the hypesthetic area recede after correction. The unanatomical distribution of the sensory loss denotes rather a circulatory disturbance than a direct lesion of the peripheral nerves. In some cases in which the anesthesia is anatomically defined, we may assume that a primary nerve lesion exists, and this is more often found in the territory of the ulnar nerve.

Trophic lesions appear, as a rule, in the more severe cases with sensory and vasomotor changes. They range from the dry cold skin, dry striated nails, and atrophy of the subcutaneous tissue, to ulcerations of the knuckles. Here, also, one often sees that the trophic lesions rapidly heal after correction of the deformity is accomplished. Ordinarily, however, all the traces of acute symptoms as well as the trophic and circulatory lesions have disappeared by the time the contracture develops. So we found trophic lesions present at the time of examination in only 1 case, although many cases had scars from trophic ulcers which occurred at early stages. Sensory lesions persisting throughout the contracture stage were observed in anatomical distribution in 7 cases, and in non-anatomical distribution in 11. Circulatory disturbances persisting into the chronic stage were found in 5 cases; while 22 cases showed none of the primary prodromal symptoms which characterized the acute stage.

On the whole, one may distinguish two types of ischemic contracture: In the first, there is a precocious and simultaneous appearance of acute symptoms and functional disability. In the second type, there is an early development of acute symptoms which run their cycle of development and disappearance and which can be considerably modi-

fied by the prompt removal of the dressing. In cases in which the acute symptoms have already disappeared at the time the retraction begins, examination shows merely the signs of the chronic stage, usually the typical claw hand with some infiltration of the skin, possibly a diminution of the radial pulse, and sometimes a persistent segmentary distribution of sensory changes which is due to secondary peripheral nerve involvement by the retracting muscle tissues.

TREATMENT

The most important phase of the treatment is the prophylaxis. First of all, there is the reduction of the fracture or dislocation itself in good apposition and the maintenance of correction; second in importance, is the position chosen for immobilization. Of the 50 cases, immediate and successful reduction was accomplished in 31 cases, and unsuccessful or late reduction in 5. It appears, therefore, that immediate and successful reduction in itself does not materially influence the incidence of ischemic contracture.

Another question is whether the incidence of contracture is lessened if plaster or metal splints are used instead of circular casts. From our own analysis, it appears doubtful that much blame can be placed upon the circular dressing as such, provided a good plaster technique is used. It seems more to the point that prophylactic measures should be directed against the primary position, which in the majority of cases was that of acute or right angle flexion. J. B. Murphy, in 1914, pointed out that prophylactic treatment consists in avoidance of compressive splints and bandages and in permitting a position of greatest comfort for the first 48 hours, never a flexed position immediately after the accident.

The treatment of the contracture. On the whole, conservatism should be the pass word for the treatment of the contracture in all its elements. The treatment of Robert Jones is generally recognized as paramount. It is admirably described in his article on "Volkmann's Ischemic Contracture" in the *British Medical Journal*, 1928. Since 1908, he has advocated gradual extension, first of the fingers, then of the metacarpophalangeal joints, and lastly of the wrist. When the wrist is completely flexed, the contractures of the fingers are lessened, and if they cannot be fully extended, they may be further straightened by completely flexing the metacarpophalangeal joints. When the fingers are straight, splints are applied to them and they are used to extend the metacarpophalangeal range. Then splints are applied reaching from the finger tips to the wrist joint and, finally, full extension of the hand is secured, the splints being used as levers to dorsiflex the wrist slowly. The splints should be taken off every day for the application of physiotherapeutic methods, consisting in several modalities of thermotherapy; the most useful of which is diathermy as it promotes best nutritive stimulation. This is assisted by mechanotherapy and massage; the former consisting in passive mobilization directed separately against the capsular contractures, which develop in the metacarpophalangeal joints as well as in the interphalangeal articulation, and against the flexion contracture of the wrist and the pronation contracture of the forearm.

Rapid redressment of the deformity, as advocated by Volkmann, Koenig, Hildebrand, and others, is on the whole unsatisfactory; it produces lacerations and invites recurrences. The gradual and slower redressment, however, as used by Froehlich, Putti, and others, by a series of corrective splints or casts, is a very effective method. On the whole, the gradual correction is better accomplished by splints in the manner indicated by Robert Jones. Instead of the rigid splint, one may use the semirigid wire splint of Ombredonne and others, or the hinged splint of the type used by Alexander, Rowland, etc.

One of the most efficient methods of gradual correction is that of elastic traction. It may be carried out by spring extension, such as in Putti's splint or in the splint models of von Recklinghausen; or by means of a glove traction splint as used in our clinic; or as the banjo splint which obtains correction by elastic traction of the fingers against the so called banjo frame. Another very useful and practical type of splint is the so called Quengel splint, devised and perfected by Mommsen.

OPERATIVE METHODS

That operative methods in the treatment of ischemic contracture are contingent upon the failure of the conservative treatment to accomplish results is generally agreed upon, and needs no further mention. The question is, however, what constitutes failure, or to put it in other terms, when is it reasonable to expect the conservative method to have reached its limit? The contracture resistance is very different in the muscles of the different joints of the extremities. The short fibered, uniarticular muscles of the wrist joint are very much more resistant in contracture than are the muscles of the fingers, which have a very much wider contraction range because of the greater length of the muscle fibers. Aside from the purely anatomical aspect of morphological variations in the make-up of the different muscles, it should be remembered next that the ischemic contractures are in all respects different from contractures seen in spastic paralysis or in attitudinal contractures. It is not a contraction; it is a passive state, and it can be shown that contracture is maintained at a minimum of oxygen expenditure, in which respect it materially differs from all active contraction. It is due to the physical nature of this contraction that for its correction continuous and steady counterforces are required, because the resistance to correction increases rather than decreases with the improvement of position—in wide contrast with contractures seen in spastic or positional conditions.

While all contractured muscles resist gradual mechanical stretching, the flexor carpi ulnaris offers by far the most difficulties. Because of its comparatively large rotation, the moment the deformity yields to mechanical pull and flexion, ulnar deviations are produced. One should not hesitate to lengthen this muscle by tenoplasty; this also applies to the flexor carpi radialis. These muscles were severed in the majority of cases.

Another muscle which offers strong resistance is the deep flexor pollicis longus. This muscle coming from the ulnar side of the radius and interosseous membrane, has a comparatively short contraction range. With these three muscles, the usual obstacles to correction are overcome, and it is only very rarely necessary to lengthen the long muscles of the fingers. These muscles have a much larger contraction range and consequently yield much better to stretching.

Transverse myotomies generally are not to be recommended except for the pronator teres and pronator quadratus; they mean as a rule, a total sacrifice of the muscle.

Stripping the flexor group off its point of origin at the internal epicondyle of the humerus is a method already advocated by Bardenheuer and Codivilla. It produces a release of the flexion contracture of the wrist; but the detachment is possible only for a short distance, ½ to ¾ inch, because of the innervation by the branches of the median nerve.

Tendon transplantations in ischemic contracture, especially transplantation from the extensor to the flexor muscles, are indicated in cases in which there is a great deal of myositic destruction. Such operation, of course, presupposes surgical removal of the scar tissue. In our cases, myotomies of the pronators were carried out in 4 instances; epicondylar stripping in 5 cases; tendon transplantations in 4 cases; conservative method of plastic lengthening confined to the wrist flexors in 27 cases; tendon transplantation using flexor carpi radialis and ulnaris for the flexors in 2 cases.

Operations on bone. Although operations on the skeleton are carried out infrequently, they may be the only suitable procedures in the severest deformities. The resection of the radius and ulna which was first carried out by Colzi in 1892, we have used in only 1 case, because of the uncertainty of the method and the possibility of radio-ulnar synosteosis. Usually we prefer the method of resection of the wrist when it is necessary to shorten the skeleton, in order to accommodate the irresistibly contracted flexor musculature.

Pouzet advocates the partial resection of the carpus, preferring it to resection of the forearm bones, as being more simple, more sure, having a better cosmetic result, and offering a better control of the ulnar deviation. The resection of the distal row of the carpus was first proposed by Phocas in 1911; later it was carried out by Klapp and others.

On the other hand, it is not infrequently necessary to resort to radical operations in

severe claw hands with subluxations or dislocations of the basal phalanges on the heads of the metacarpals. In these cases it is usually not sufficient to resort to capsular stripping. One must often resect the metacarpal heads, since a claw hand of that degree is not manageable in any other way. The resection of the metacarpal heads was carried out in 1 case.

Operations on nerves. Neurolysis is recommended in those cases in which a primary involvement of the ulnar and median nerves appears likely; that is in more or less anatomical distribution. At operation one may find anything from a few constrictions of the nerve to scar tissue and complete strangulation. Occasionally, neurolysis should be combined with transposition of the ulnar nerve.

The question of the effect of surgery upon the circulatory aspect of ischemic contracture needs further discussion. Leriche is a principal advocate of arterial surgery, and reports of Matthieu and others on arteriectomy of the brachial artery seem to indicate that some improvement in regard to certain aspects of the deformity can be expected. Putti also has reported good results from this method. On the other hand, we find nothing in the literature regarding the effects of ramisection in ischemic contracture.

In our series, neurolysis was carried out in 2 cases with good results; and neurolysis of the ulnar nerve with transposition was performed in 2 other cases. A skin graft was necessary in 1 case to cover a scar caused by trophic ulcers.

The mechanical after-treatment both in conservative and operative management is so generally emphasized that it is not necessary to say more. It is the backbone of the treatment, and there is no complete or lasting result without it. A single massage and mechanotherapy sitting need not exceed 15 or 20 minutes for the extremity. It should be preceded by the application of radiant heat, whirlpool or paraffin bath. The massage should be followed then by passive motion and the application of splints. We believe also that active motion of the hand may be carried out with great advantage under water. Graphic records should be made both of position and range of motion in order to follow up the effect of the treatment.

It should be borne in mind that the restoration of form, accomplished by conservative and operative methods and followed by mechanical measures, is only one side of the treatment. Restoration of function is the other, and this depends largely upon muscle reeducation. It is a matter of rather prolonged training and drill. Under these conditions the treatment of more severe cases may easily occupy 1 year or longer; while the more favorable cases may show definite results after a period of 6 months.

END-RESULTS

In a series of 50 cases of ischemic contracture, 43 were treated. Eleven cases were treated conservatively only; of these: 4 showed good results; 1, fair; 1, poor, and 5, undetermined. Thirty-two cases were treated by operation; of these: 8 were good; 8, fair; 4, poor; and 12, undetermined.

In presenting this summary of end-results, it is hardly exact to compare the achievement of the treatment without due regard for the difficulties offered by the individual case. Sometimes a moderate end-result in a desperate case is more of an accomplishment than a brilliant correction in a mild deformity. But in nearly all cases we are confronted with a problem of reconstruction involving many therapeutic phases, and not with a single corrective maneuver. All in all, this deformity offers great possibilities for rehabilitation under well laid plans.

THE IODINE RELATIONSHIPS OF THYROID DISEASE[1]

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THAT iodine is of consequence in the investigation of thyroid disease long has been a matter of common knowledge. The thyroid gland is a principal storehouse for iodine; the thyroid hormone has a high iodine content, and the use of iodine in the prevention and treatment of goiter is household conversation. Nevertheless, during the past decade, newer facts have been added to the iodine story. It is now established that iodine is constantly present in human blood. *Presumably* a part of this is actually circulating thyroid hormone. There also occurs a constant daily loss of iodine in the urine. The level of the blood iodine fluctuates, likewise the daily excretion of iodine in the urine. There is prophetic significance to these newer facts when applied to the problem of thyroid disease.

HISTORICAL SKETCH

Fortunate indeed was the empiricism which led to the ancient use of burnt sponge in the treatment of goiter. Iodine was unknown. Its actual discovery came later and then accidentally by Courtois in 1811 when it was revealed a by-product in the preparation of war materials for one of the Napoleonic wars. Within a few years Sir Humphrey Davy isolated iodine from sponges, seaweed, and other forms of marine life.

This is not the time or place to tell the story of the subsequent century of clinical iodine research extending from Straub, of Berne, to Plummer, of Rochester. It must suffice to sketch, if ever so briefly, certain of the highlights of this hundred years of fruitful investigation, in order that a background may be set for present trends and progress.

As early as 1831 Boussingault made one of the first endemicological studies in the goitrous regions of the Andes. This study demonstrated a significant relationship between iodine and goiter. Subsequent investigation led, in 1849, to Prevost's theory which related iodine deficiency to the incidence of goiter. This fundamental theory was soon substantiated by the numerous iodine analyses made by Chatin. However, while Chatin's work (1850-1876) was recognized, it was not at the time generally appreciated. The analytical method which he used was difficult, and contemporary chemists were unable to duplicate his findings.

Following the unsuccessful French experiment in 1860, the significance of iodine as related to thyroid disease received a setback. During the ensuing 35 years, other theories arose concerning the nature of goiter. It was during this period that the infection theory gained credence. This was doubtless due to the contemporary discoveries of Pasteur.

A number of unsuccessful attempts had been made to demonstrate the presence of iodine within the thyroid gland. One of these was in Kocher's clinic at Berne. In 1895 Baumann succeeded in isolating considerable quantities of iodine from normal thyroid glands. This he demonstrated to his colleagues in its characteristic violet vapor form in tubes. It is of particular interest to us that this investigation was suggested to him by Kraske, at that time professor of surgery at Freiburg. The significance of the discovery was quickly and widely appreciated.

Twenty-four years later Kendall succeeded in isolating thyroxine. The isolation was repeated by Harington, who later determined the correct molecular structure. Working from this formula, Harington synthesized thyroxine. Natural or synthetic, thyroxine is two-thirds iodine. Owing to the high iodine content of the thyroid hormone, the intake, circulation, distribution, and excretion of iodine were then more carefully considered. In brief, the metabolism of iodine was investigated. Advances soon followed.

METHODS

To investigate iodine metabolism necessitated the development of analytical methods sufficiently sensitive, yet at the same time sufficiently accurate, to determine truly minute amounts of iodine. The iodine content

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of the thyroid gland is comparatively high, hence it had long been readily determined by the older, coarser quantitative methods. The usual iodine content of the blood, urine, and tissues, however, is so minute that it was not even detected by the usual available methods. This difficulty was soon answered. In 1923 von Fellenberg, at the request of the Swiss Government, devised an adequate method for the microdetermination of iodine as it occurs in nature. To accomplish this he perfected and eventually synthesized principles from other known existing quantitative procedures. His micromethod will determine 0.0001 milligram (one ten-thousandth of a milligram) of iodine. This method has been extensively applied. By it von Fellenberg, and particularly his pupils Sturm and Lunde, have opened a new approach to the relation between iodine and thyroid function in health and in disease. Von Fellenberg's wide and convincing studies, made 75 years after the pioneer work of Chatin and other investigators, have given a belated confirmation to their pioneer work.

During the past 6 years, a group of us—Davis, Cole, Phillips, Barron, Matthews and Puppel—for whom I act as spokesman, have investigated extensively various features of iodine metabolism. We have studied experimental animals, normal people, ambulatory and hospital patients and over 250 patients with various thyroid diseases. For determining the iodine, we used first a micromethod devised by Davis and later one further perfected by Phillips. Both are essentially developments of the original von Fellenberg procedure. Our experience amounts now to more than 6,000 iodine determinations. It is difficult adequately to cover any save the highlights of this material. However, I wish to discuss certain features of three iodine relationships of thyroid disease. These concern, first, the iodine of the thyroid gland; second, the iodine content of the blood; and third, the loss of iodine in the urine.

THYROID GLAND IODINE

The normal human thyroid gland ordinarily contains about 10 milligrams of iodine (Remington), at a concentration of 40 milligrams per cent, wet weight. This is found principally in the colloid (Van Dyke). There is a geographic variation in the iodine content, the higher amounts being found in glands of inhabitants in oceanic cities. In glands from districts where goiter is severely endemic, as in certain parts of Switzerland, the thyroid iodine is decreased. There is likewise a seasonal variation. Iodine appears to be stored during the summer since the gland content is highest during this period. An ebb ensues during the fall; during the winter the thyroid iodine is at its lowest level, averaging about 8 milligrams. This cyclic fluctuation in iodine storage corresponds to the blood iodine level, which is lowest during the winter months (Sturm, 33).

In patients with genuine exophthalmic goiter, the thyroid iodine is decreased. It may be as low as 3 milligrams. This was originally recognized by Baumann and has since been amply confirmed. The associated absence of colloid in the hyperplastic alveoli is generally recognized. This particular loss of iodine from the diffuse hyperplastic thyroid is one of the iodine deficiency features of exophthalmic goiter.

Subsequent to lugolization, a phase of iodine storage ensues. In this manner iodine therapy replaces the deficiency, and the hyperplastic alveoli fill with colloid. The thyroid iodine increases and becomes considerably greater than normal. During this period, the blood iodine is greatly increased. However, the alcohol insoluble portion, presumably the thyroid hormone, is decreased (Lunde). This suggests an induced reversal in the polarity of the thyroid cell, changing its activity from hypersecretion to storage, and initiated by increased iodinization. The clinical improvement is well recognized. It would appear that the thyroid cells are then storing rather than secreting eventually into the blood stream. The iodine content of an excised gland, removed after adequate pre-operative iodinization, is uniformly high. However, there is a variation in the iodine content of different parts of these diffusely enlarged glands.

Nodular goiters are more variable in their morphology. Hence it is difficult to arrive at any clear conception of the iodine relationships of the differing portions of these glands

in this form of hyperthyroidism. Their iodine content is most varied. In 1 large goiter, it ranged from 4 to 112 milligrams per cent, dry basis. The normal thyroid gland contains about 200 milligrams per cent, dry basis. Colloid nodules from diverse portions present great variation in their iodine content.

The iodine content of the fluid from cysts is low. The hyalin-like substance found in the larger cysts has a low iodine and a high iron content. This would indicate its hematogenous origin (von Sinner), since in thyroid colloid, the reverse occurs.

BLOOD IODINE

The normal iodine content of human blood is about 12 micrograms per cent (0.012 milligrams per cent). This means that normal blood contains about 120 parts of iodine per billion. A microgram, often designated a *gamma*, is one one-thousandth of a milligram. It corresponds in gravimetric measurement to the micron of linear measurement. Thus the entire iodine content of the human blood stream is ordinarily less than 1 milligram. In normal individuals the blood iodine, as determined by Phillips' method, ranges from about 9 to 14 micrograms per cent. The range and average is a little lower during the winter months, increasing during the spring and early summer (Nitzescu and Binder). Certain variations of normal physiology, notably menstruation and pregnancy, influence the blood iodine. This is increased during early menstruation (Maurer). This newer evidence permits of a more careful analysis of the cyclic correlation between ovarian and thyroid function.

By adding alcohol to the blood, the blood iodine may be separated into two fractions (Sturm, 33; Lunde). One of these remains in the coagulum even after repeated subsequent alcohol extractions. It is thus alcohol insoluble and is designated, the "organic" fraction. The other portion, the "inorganic" fraction, is alcohol soluble. The organic fraction is presumably the thyroid hormone (Holst). The inorganic fraction appears to be largely the iodine of nutrition.

Although the blood iodine is definitely affected by diseases of the thyroid gland, the majority of patients with other than thyroid diseases reveal a normal blood iodine. Thus tuberculosis, fractures, chronic osteomyelitis, chronic arthritis, simple infections, obesity without hypothyroidism, hirsutism, lymphoblastoma, and furunculosis ordinarily cause no change in the blood iodine level. In patients with cancer, the blood iodine is within normal range.

Certain other diseases, however, are accompanied by changes in the blood iodine. That of the neurasthenic may be decreased. In the leucemias, both lymphatic and myelogenous, the blood iodine is increased, and the basal metabolic rate is elevated. Total thyroidectomy has been of benefit to 2 of our patients.

In certain severe infections, in osteitis deformans, in certain patients with hypertension, in hypertensive heart disease, and in certain patients with congestive heart failure, we have observed an increase in the blood iodine. The mechanism is not entirely clear. Further investigation is necessary. Blood should be drawn from these patients for analysis in the postabsorptive state. Too, they should not receive iodine in any form, save the normal food and water intake.

The blood iodine is as a rule increased in patients with hyperthyroidism. In our experience about 10 per cent of the determinations may fall within the higher normal range. The average increase, to 27 micrograms per cent, is greater in patients with diffuse hyperplastic goiters with or without exophthalmos than in patients with toxic nodular goiters (average of 22 micrograms per cent). There is a seasonal variation in the hyperiodemia of hyperthyroidism which reverses the normal cycle (Breitner). The increase is accentuated by menstruation and by pregnancy. Fractional analysis of the hyperiodemia reveals that the increase is principally in the organic fraction (Lunde), which is further evidence of the hyperthyroidism.

Subsequent to iodinization with Lugol's solution or for that matter any form of iodinization thus far investigated, there ensues a sharp increase in the hyperiodemia. Since this is associated with obvious clinical improvement, as shown by the abatement of the principal symptoms, the findings seem at first

paradoxical. The work of Lunde and his associates, however, affords a convincing explanation. The *increase* is principally in the inorganic fraction and is due to the medication; while there is a *decrease* in the alcohol insoluble, organic fraction. Thus the circulating thyroid hormone presumably is lessened.

Immediately following thyroidectomy, a rise in the blood iodine of non-iodinized patients occurs. So far as I am aware, this has not been fractionated. There is usually a fall in the level following thyroidectomy on patients treated with Lugol's solution. The blood iodine then remains irregularly increased so long as postoperative iodinization is continued. The level then depends upon 2 factors: the amount of iodinization, and the time which has elapsed since the last administration.

Subsequent to an adequate thyroidectomy for hyperthyroidism and the cessation of postoperative iodinization, the blood iodine eventually decreases to a low normal level. If the thyroidectomy is inadequate, or if but a single lobectomy is performed, the hyperiodemia persists, in varying degree. Likewise, in an iodine vacation, either subsequent to iodinization for intercurrent disease or between the stages of a two stage lobectomy, the blood iodine is increased. At the beginning of the iodine vacation, high normal values may be found.

The blood iodine relationships of toxic nodular goiter are similar to those of exophthalmic goiter. We have observed thus far no constant and essential difference.

There is no constant and specific correlation between the blood iodine and the basal metabolic rate. In general, both are increased in hyperthyroidism. Thus 11 patients with exophthalmic goiter presented a blood iodine averaging 27 micrograms per cent and a basal metabolic rate averaging plus 50. One of these patients had a blood iodine of 26 and a basal metabolic rate of plus 19. Another presented a blood iodine of 23 and a basal metabolic rate of plus 96. This holds for normal individuals as well as for patients without thyroid disease.

Patients with unmedicated hypothyroidism have a decreased blood iodine. This is true for dwarf cretins, for cretins with goiter, for children with juvenile myxedema, for adults with a low basal metabolic rate and other evidence of thyroid underfunction, and for patients with postoperative myxedema. Perhaps the best evidence we have of the decreased blood iodine in patients with hypothyroidism is that following total thyroidectomy for congestive heart disease; there ensues a transient increase in the blood iodine, persisting for about 24 hours. After variable periods, it then progressively *decreases to about one-third normal*, averaging 4 micrograms per cent. So far as I am aware, this has not been fractionated. However, it is of peculiar interest in that it corresponds quantitatively to the inorganic fraction of normal blood (Sturm). It would appear to be due to the iodine of nutrition.

The administration of thyroxine which is 65 per cent iodine, to patients with hypothyroidism is followed by a prompt increase in the blood iodine. This may be great at first. Similar results follow the administration of desiccated thyroid, but the subsequent change is not so pronounced, however, since dried thyroid (U. S. P.) contains but about 0.20 per cent of iodine. In patients with hypothyroidism, the continued administration of controlled adequate amounts of desiccated thyroid stabilizes the blood iodine at a high normal level.

In other thyroid diseases the blood iodine varies with the corresponding change in thyroid function. Thus, it was increased in 2 patients with carcinoma of the thyroid, and normal in a third. The absence of specific correlation between the blood iodine and the basal metabolic rate is again evident in patients with thyroid cancer.

The blood iodine is at a low normal range in patients with Riedel's struma. In this disease the extensive sclerosis destroys progressively thyroid alveoli and secreting thyroid cells. In 1 patient with struma lymphomatosa (Hashimoto), the blood iodine was within the normal range previous to a partial thyroidectomy. Two patients with a median thyroglossal sinus and 1 with a patent thyroglossal fistula presented low blood iodines. Three patients presented, after operation, developing exoph-

thalmos subsequent to adequate subtotal thyroidectomy for diffuse hyperplastic goiter with hyperthyroidism. Investigation of their blood iodine and of their basal metabolic rate revealed normal findings. Thus no residual hyperthyroidism could be demonstrated by laboratory investigation.

URINARY LOSS OF IODINE

It is a well recognized physiological observation that the urinary excretion of crystalloids is closely related to their concentration in the blood. As a consequence, we began long ago the investigation of the urinary loss of iodine, particularly in patients with thyroid disease.

The daily loss of iodine in the urine of normal individuals, and of University Hospital patients without evidence of thyroid disease, is variable. The factor of food iodine intake is inconstant and must be taken into consideration. Thus on 4 successive days, the food iodine intake of 1 of our goiter patients was 161, 196, 168, and 207 micrograms. The urinary loss of iodine for the same 4 days was 121, 111, 103 and 118 micrograms (Cole, Curtis, and Bone). The food intake of this patient was increased because of pregnancy. From 10 to 43 successive determinations made on 10 different individuals gave averages of from 36 to 78 micrograms daily. The grand average of over 200 determinations was 55 micrograms. Nine of the 10 were maintained upon the usual hospital diet. Iodized salt was not used, and sea foods or other foods known to be high in iodine were avoided.

Patients maintained for days upon a constant monotonous diet have a remarkably uniform daily loss of iodine in the urine. Thus 1 normal male subject under strict hospital control ingested 156 micrograms daily. During 4 successive 3 day periods the daily iodine excretion varied from 43 to 53 micrograms, averaging 48. A normal female subject ingested 56 micrograms daily and similarly excreted 36, 36, 36, 31, and 35 micrograms. Concerning these patients, there is a considerable daily iodine loss in the stool and sweat (Cole and Curtis).

During certain phases of the disease, patients with hyperthyroidism lose an increased amount of iodine in the urine (Curtis and Phillips). Thus 1 woman with toxic nodular goiter of 4 years' duration excreted from 405 to 628 micrograms daily during a 7 day period. The average daily loss was 483 micrograms, approximately nine times normal. Her blood iodine varied from 22 to 27 micrograms per cent, and her basal metabolic rate varied from plus 46 to plus 49 during the same period.

That an iodine diabetes occurs during the course of hyperthyroidism is demonstrated further in an investigation of 5 patients, women from 27 to 73 years of age, with toxic nodular goiter. The basal metabolism varied from plus 18 to plus 69, averaging 43; the blood iodine varied from 15 to 37 micrograms per cent, averaging 22, and the daily loss of iodine in the urine ranged from 139 to 483, averaging 304 micrograms, which is six times normal.

Likewise, in 11 patients with diffuse hyperplastic goiter with hyperthyroidism, an increased loss of iodine in the urine was demonstrated. Of these, 7 were women and 4 were men, their ages ranging from 17 to 51. Their basal metabolic rates varied from plus 18 to plus 109, averaging plus 69. The blood iodine varied from 14 to 35, averaging 26 micrograms per cent. The daily iodine excretion in the urine ranged from 65 to 310 micrograms daily, averaging 157, a threefold normal.

Two evidences of iodine deficiency are thus demonstrable in patients with hyperthyroidism: (1) the decreased iodine content of the thyroid gland, and (2) the increased loss of iodine in the urine. Also certain of our results concerning the loss of iodine in the urine following total thyroidectomy support the hypothesis that there is a loss of iodine from the tissues.

Further evidence of the existence of iodine deficiency in patients with hyperthyroidism is shown by their usual response to iodinization, a form of replacement therapy. Investigation of the urinary excretion of iodine previous to and following the quantitative administration of 10 milligram doses shows at first but a small percentage excreted in the urine. Later, as the depleted thyroid gland and presumably the tissues become repleted, the administered

iodine is more nearly quantitatively excreted in the urine, showing that the deficiency has been overcome. These facts form the basis of an iodine tolerance test, since patients with hyperthyroidism tend to retain iodine administered in small amounts.

In patients with diffuse non-toxic colloid goiters, the urinary iodine loss is normal. Thus, in one woman of 29, it ranged from 36 to 65, averaging 58 during an 8 day period. In a woman of 22 with a non-toxic colloid goiter, it ranged from 51 to 73 micrograms during a 7 day period.

There is a periodic increase in the urinary excretion of iodine in women during the course of the complete menstrual cycle (Cole and Curtis). Thus, 1 woman lost 42 to 53 micrograms daily just previous to the onset of menstruation, 108 to 112 during menstruation and 41 to 65 during the days immediately following. The blood iodine rose to 43 on one of the days of the increased iodine loss. These cyclic variations of iodine loss in the urine appear to be associated with the periodicity of ovarian activity. By investigating the blood and urinary iodine, it would seem possible to correlate more closely thyroid and ovarian function.

An increased urinary loss of iodine also occurs during certain periods in the course of pregnancy (Enright, Cole, and Hitchcock). If iodine deficiency is of major significance in the etiology of goiter, then women should have goiter more frequently than men owing to this periodic and gestational loss.

Subsequent to partial thyroidectomy for the various forms of goiter, there is a great increase in the urinary loss of iodine, sometimes as great as 2 milligrams during a 24 hour period. The source of the excess iodine lost has been of interest. Manipulation of the gland during the resection was at first regarded as a likely possibility. Too, after resection a certain amount of necrosis follows, and the associated fluid exudate has considerable iodine content, a part of which may be resorbed and excreted. On the other hand, an increased urinary loss of iodine follows total thyroidectomy (Curtis and Barron). No raw areas of thyroid gland are left behind in this procedure. Moreover, an increased urinary excretion of iodine follows surgery upon remote parts other than thyroid. The loss of iodine from the extrathyroid tissues suggests interesting problems concerning the function of iodine in man, probably iodine has another function in nutrition separate from that of furnishing the high iodine content of the thyroid hormone.

Hyperthyroidism is characterized by a number of salient features. To the original Merseberg triad have been added Chvostek's tremor and certain clinical signs. From the laboratory have come other contributions. The basal metabolic rate is elevated. The blood iodine is increased. Another characteristic may now be added, an increased loss of iodine in the urine (Curtis and Phillips).

CONCLUSIONS

Biochemical progress has thus opened a new approach to the iodine relationships of thyroid disease. The thyroid gland is a principal storehouse for iodine and doubtless exerts a regulating effect upon iodine metabolism. However, there is evidence to indicate that iodine has another function in nutrition separate from that of forming two-thirds of the thyroid hormone.

Consequent clinical investigation has established the significance of the blood iodine as a measure of thyroid function. It is an aid in the diagnosis of toxic goiter. The significance of the urinary loss of iodine is becoming clearer upon investigation, and the increased excretion of iodine in the urine of patients with hyperthyroidism is of manifest consequence.

Diabetes mellitus is characterized by an increased blood sugar and a sugar diabetes. In the more recently recognized hyperparathyroidism, there is found an increased blood calcium and a calcium diabetes. Now we add that patients with hyperthyroidism present an increased blood iodine, and during certain phases of the disease, an iodine diabetes. These findings throw light on several poorly understood features of toxic goiter.

By investigating iodine metabolism, it is becoming possible to leave the earlier empiricism and to adopt a more scientific use of iodine in the prevention and treatment of goiter. In this direction lies progress.

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Discussion

WALLACE I. TERRY, San Francisco: The painstaking studies of Dr. Curtis and his associates are a distinct addition to our knowledge of the relationship of iodine to the thyroid gland. Much of our use of iodine in goiter is empiric and haphazard and it is to be hoped that continued research by Dr. Curtis will put its use on a scientific basis.

The technique of the microchemical iodine determinations is beyond the province of the usual hospital clinical laboratory, but many medical schools have chemists who can carry out the method with sufficient exactness to give us data from the various goitrous and non-goitrous regions. It would be most interesting to compare the readings for iodine in the thyroid gland, the blood, the urine, the feces, and the foods of Tibetans, for instance, with similar readings of people who live in distinctly non-goitrous regions. Many of the Tibetans spend all their lives at altitudes of 18,000 feet or more where the soil is presumably washed free of iodine and where endemic goiter is exceedingly common, according to the reports of travelers. Possibly the normal level of 12 gammas per cent of blood iodine is maintained, but it seems reasonable to expect that the elimination of iodine from the kidneys and intestines would be found below normal in these Tibetans.

Toxic adenoma of the thyroid and hyperplasia, or exophthalmic goiter, have been considered by some to be essentially the same disease. Against this theory are the following points: one is slow in onset and development, the other is rapid; exophthalmos is not found in toxic adenomas unless there is also some hyperplasia of the thyroid proper; the basal metabolic rate may be subnormal, normal, or increased in toxic adenomas, whereas it is uniformly increased in exophthalmic goiter; the clinical courses of the two diseases are quite different. It seems to

me that Dr. Curtis has added another point, namely, that the blood iodine is higher in exophthalmic goiter than in toxic nodular goiter.

The prevention of excessive regeneration after resection of the thyroid for hyperplasia by the administration of iodine succeeds well in some cases and fails in others. Is the difference due alone to inadequate resection of the gland, or to insufficient doses of iodine, or do patients react differently to iodine?

We know that the thyroid gland in exophthalmic goiter can utilize only a small fraction of the total amount of iodine contained in an ordinary dose of Lugol's solution given before operation. Why should we not give small doses and would there be any advantage in giving an organic form of iodine rather than the inorganic?

I feel that Dr. Curtis and his associates are in a position ultimately to answer these and many other queries about iodine.

THE DIAGNOSIS OF ENDOMETRIAL HYPERPLASIA[1]

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As much has been written regarding the research work on hyperplasia, I will not discuss the subject in great detail. I should say, however, that were it not for the investigative work that has been carried out by the various workers abroad and in this country, the treatment of uterine bleeding from hyperplasia would have advanced but little. The details of these investigations have been discussed in Fluhmann's classic paper and in a recent paper by my colleagues (1). In these papers the notable contributions of the California investigators have been thoroughly discussed.

The chief symptom of glandular cystic hyperplasia of the endometrium is bleeding. In many cases this bleeding is indistinguishable from that produced by other conditions, and in order to arrive at a correct diagnosis, a diagnostic curettage with a study of the scrapings is necessary. The experience of the past years has shown convincingly that much more diagnostic accuracy can be obtained from the ordinary history and physical examination than is generally regarded as possible. Our experience has been that the newer methods of obtaining uterine biopsies are so satisfactory that diagnostic curettage can be eliminated in a large percentage of cases. Studies of the material obtained from the uterus have been most interesting and instructive. From them has originated a large number of investigations of fundamental importance, as well as of practical significance. It is the purpose of this paper to discuss the diagnosis of the condition in the light of these studies.

CLINICAL CONSIDERATIONS

The disease is more frequently encountered than is generally realized and is perhaps the most common form of hemorrhage that the gynecologist encounters. It occurs at all ages but is most common after the thirty-fifth year. Frequently there is a history of childbirth, abortion, or debilitating disease. A noticeable number have had pelvic operations or ovarian resections. Endocrine stigmas are frequently present; they are more common in the younger groups than in the older.

Bleeding is the chief symptom. It is often preceded by a definite period of amenorrhea. It is painless, profuse, and usually prolonged. The bleeding is checked from time to time, and then tends to recur. On examination there may be found constitutional evidence of the cause or the effect of the disease. Anemia is of course to be expected. The basal metabolic rate is generally low, but rarely does it reach the frank myxedematous level. The galactose tolerance test is variable; it may be normal or low. Achylia gastrica is sometimes noted. On pelvic examination the cervix is often found to be soft and may be open. The uterus is variable and may be normal in size, or enlarged and thickened; frequently it contains fibroids. In typical cases there is an ovarian enlargement resulting from the presence of a follicle cyst.

DIFFERENTIAL DIAGNOSIS

Eighty-five per cent of the cases of uterine bleeding are due to one of the five following conditions: cancer, abortion, fibroid tumor, extra-uterine pregnancy, or endocrine dysfunction. I impress this on my students by making them remember the word "cafee," each letter in the word standing for one of the five etiological factors. There are many local and constitutional conditions besides the five mentioned that may produce uterine bleeding, but they are limited to 15 per cent of cases. Abortion is differentiated from hyperplasia by the history of pain, the examination of the fragments that are passed, and the use of the Aschheim-Zondek or Friedman test. Extra-uterine pregnancy is sometimes mistaken for hyperplasia. I was deceived by this in a private patient this last summer. She was quite fat and had never had a regular monthly cycle. She had been bleeding for 2 weeks before she applied for treatment. There

[1]Presented before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

was nothing unusual found on physical examination. A vaginal examination disclosed the cervix a little soft, the uterus normal in size and position, and the appendages not palpable. The usual routine biopsy was taken from the endometrium and basal rate the next morning showed −10. A provisional diagnosis of hyperplasia was made. In a few days she had rather a severe pain that brought her to her knees and was associated with a fall in blood pressure. An examination at the hospital showed a very distinct mass and at operation an extra-uterine pregnancy was found. It is well to bear in mind that both hyperplasia and extra-uterine pregnancy have uterine bleeding and pelvic masses. If an accident has not occurred to the pregnancy, both may have masses and be painless. In a condition like this, the Friedman test will be of great assistance. Fibroids sometimes offer a perplexing problem in differential diagnosis. Both cause uterine bleeding and an enlargement of the uterus. In a certain number of fibroids, the bleeding comes from the associated hyperplasia. Fibroids *per se* do not cause bleeding unless the tumor encroaches on the endometrium, or unless a fibroid polyp becomes twisted or ulcerated. The chocolate flow or spotting before or after the period is rare in fibroids. Unless it is definitely determined which is responsible for the bleeding, the patient may receive treatment for one and be suffering from the other. Under certain conditions the treatment of the two is essentially different, and if this point is borne in mind, many proposed operations will prove unnecessary.

The differential diagnosis between cancer of the body and hyperplasia is most important, and an error here may mean an unnecessary loss of a life. A close liaison between the laboratory and the clinician is absolutely essential. I am firmly convinced that in teaching and also in large hospitals, the department of obstetrics and gynecology should maintain its own pathological laboratory headed by one who is an expert in this special form of pathology. Cancer of the uterine body usually occurs in older patients than does hyperplasia. I have never seen the two conditions associated together in the same patient, nor have I ever seen hyperplasia as a forerunner to cancer. Both conditions have uterine bleeding and both frequently have some enlargement of the uterus. The diagnosis must depend on the biopsy. Our department has found 7 cases of unsuspected cancer of the body of the uterus in the last year by means of the biopsy instrument. If this instrument is not at hand, curettage must be used for biopsy purposes. It should also be carried out if the biopsy specimens obtained with the instrument are suspicious or unsatisfactory. An accurate diagnosis must be made. Cancer of the body demands a radical operation. Hyperplasia may be treated by conservative measures. The prognosis of the disease as regards life is good, although fatal cases have been reported. Some patients, for no apparent reason, spontaneously recover, while others continue to bleed and require treatment. Pregnancy may occur after a spontaneous recovery. In other instances, a cessation of the bleeding is followed by long periods of amenorrhea which are permanent in the older age groups.

In all cases in which the differential diagnosis is not clear, an exploration of the uterus is advisable. This can be done by means of the curette or the biopsy instrument. The first instrument which we used was an ordinary hollow metal cannula (5). This was passed into the uterus, and strong suction was made at several points by means of an attached syringe. In the majority of cases satisfactory tissue was obtained. Lorincz has modified the method by the use of suction obtained from a motor driven pump. Novak has recently recommended this modification. We are now using a small metal punch which can be passed through the cervix as easily as an ordinary uterine sound. A bite is taken from the endometrium, then the position of the instrument is changed and another bite taken. The instrument is then withdrawn and one is agreeably surprised to find two good sized pieces of tissue, large enough to satisfy the most exacting pathologist. The method has been used hundreds of times in our clinic. It is not painless, but the pain is never severe enough to require an anesthetic. It is used routinely as an office or dispensary procedure.

The instrument, of course, can be re-inserted an endless number of times and as much tissue as desired can be obtained. Some have objected to the method on the grounds that it cannot completely explore the cavity of the uterus as well as the curette, and it must be admitted that this criticism is just. It is our practice first to use the biopsy instrument, and, in doubtful cases, to supplement it with the curette. We are unaware of any cancers that have been overlooked. In one case in which a curettement was done, a non-malignant endometrium was found and the bleeding continued. A subsequent biopsy revealed a cancer. We routinely use the method in all suspected cancer cases, as we believe that the danger of disseminating the growth is less with this method than with the curette. In case a cancer is not found, curettage might be indicated.

The interpretation of endometrial tissue, as well as the treatment of endometrial lesions, requires an understanding of the physiology of the female sex cycle. Before these two important phases of the subject are considered, it would seem wise to review the physiological essentials briefly.

Following menstruation, the endometrium undergoes a gradual proliferation up to the time of ovulation which occurs at about the ninth postmenstrual day. Then the epithelium ceases to proliferate and begins to undergo secretory changes. When menstruation begins, the epithelium disintegrates and is cast off. These cyclic changes in the endometrium are dependent on cyclic changes occurring in the ovary. In the latter organ there is a period of follicular ripening following menstruation. On or near the ninth postmenstrual day, this process terminates in the rupture of the follicle and the discharge of the ovum. Following follicular rupture or ovulation the lining cells of the ruptured follicle begin to grow and to form a corpus luteum. During the process of follicular ripening, the ovary secretes a hormone which stimulates the growth of the endometrium. After ovulation the corpus luteum furnishes an additional hormone known as progestin. The proliferative changes produced in the endometrium by estrin are modified by progestin in such a manner that the secretory or premenstrual endometrium results. This premenstrual endometrium is cast off at the time of menstruation. The actual cause of the menstrual bleeding is considered by some to be a special menstrual hormone originating in the anterior pituitary. Others believe that menstruation is a degenerative process resulting from a decline in the ovarian hormones. At present the preponderance of evidence supports this latter view. The menstrual bleeding which follows the removal of the human ovary containing the corpus luteum lends support to this theory.

The important studies of Smith and Engle and Zondek and Aschheim have conclusively demonstrated the dependence of the ovary on the anterior lobe of the hypophysis. If the anterior hypophysis is removed the ovarian function ceases; this in turn causes a cessation of endometrial activity. There is likewise a cessation of endometrial activity if the ovary is removed. These facts indicate that the pituitary influence on the endometrium is mediated by the ovary. It is known that the ovary, in turn, has a reciprocal action on the anterior pituitary. The exact nature of this action, unfortunately, is not known at present.

From a correlative study of ovarian and uterine changes, Schroeder found that the uterine changes before ovulation were caused by a hormone from the follicle, and those after ovulation by a hormone from the corpus luteum. In endometrial hyperplasia he found no corpora lutea, and he concluded from this that the endometrial changes were the result of a failure of ovulation. This resulted in a persistent follicle which stimulated the hyperplastic growth of the endometrium. Experimental proof of Schroeder's contention of an abnormal follicular stimulation producing the hyperplastic changes has been advanced. By injecting spayed rodents with estrogenic hormones, typical hyperplasia has been produced. This work has recently been confirmed in monkeys (12) and in man (4).

The study of known cases of endometrial hyperplasia by means of biopsies taken every few days in the same patient has been most interesting and instructive. Cases have been observed over a long period of time. The

endometrium is not always constant, but varies from time to time. At times it is typically hyperplastic; at other times it is similar to the normal interval endometrium. Bleeding may occur from the endometrium of the frankly hyperplastic type or from the one resembling the normal interval endometrium. In the latter instance, a section would be considered as normal by the pathologist if judged by morphology alone. However, if considered in the light of the menstrual history and with the knowledge that this type of endometrium is simply an early stage in the development of frank hyperplasia, the diagnosis becomes obvious. It is advisable, therefore, to obtain biopsies near to the onset of bleeding and to consider the menstrual history as well as the section before arriving at the pathological diagnosis.

Endometrial hyperplasia is fundamentally a disorder of the hypophyseal ovarian relationship. The nature of this disorder varies, and there are several possible variations. In addition, the hypophyseal ovarian relationship is influenced by other constitutional conditions such as tuberculosis, hypothyroidism, or protein starvation, etc. The bleeding is to be considered only as a local symptom of an underlying general condition. To stop the bleeding is to administer symptomatic treatment. To recognize the underlying condition and to correct it, which at once relieves the bleeding, is to administer curative treatment. An attempt to recognize this underlying condition should be made in all cases by means of the recognized clinical methods which are used in this type of work and which are familiar to all studying the ductless glands. If such an attempt is not made the patient may be relieved of a symptom but may still retain the primary condition. In a general way, curative measures alone should be used in the younger patients. In older patients, curative and symptomatic measures may be indicated. Among the curative measures of value are anterior lobe substance, anterior pituitary gonadotropic hormones, dihydroxy estrin benzoate, thyroid extract, progestin, and the gonadotropic substances of pregnancy urine. Their objective is to restore the normal hypophyseal ovarian relationship. Among symptomatic measures, curettage is to be considered as a simple temporary hemostatic. It usually stops the bleeding, and is of use before curative treatment has had an opportunity to take effect. The use of snake venom has been highly recommended for its hemostatic qualities. Hysterectomy is rarely indicated and is reserved for those young women in whom curative measures have failed. Radiation, depending on the dosage, may be either stimulative or depressive. Stimulative doses are indicated in ovarian underfunctions in young subjects, while depressive doses are used at the time of the menopause. In the menopausal group, curettage followed by radium has proved satisfactory.

The replacement of the curette by the biopsy instrument and the use of X-ray therapy instead of radium has eliminated the necessity of hospitalization for many of these patients and, to an increasing number, has proved an easy and satisfactory solution of the problem.

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SOME ASPECTS OF MATERNAL NUTRITION[1]

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THERE has existed in Canada during the past 5 years the increasingly vexing problem of the inclusion in the family food budget of an adequate and well balanced allowance for the pregnant or nursing mother. This is especially true if the family is on relief, or if the wage-earner's pittance demands the economy exercised by relief measures. The mother then must be instructed in not only what kind and amount of food to eat and drink, but from what foods the essential elements are easily and cheaply obtained. Moreover she must be shown how her food needs can be blended with the ordinary family meals so that a too great inconvenience in food preparation may be avoided.

The foregoing facts are generally known, it is true, but it is our opinion that there is lacking a definiteness in both the application and dissemination of that knowledge to obstetrical patients. We propose first to offer a brief summary of the dietary needs of the pregnant and nursing mother, and then to show how these can be secured easily and with relative economy.

It is best that no rigid diet be prescribed for the average pregnant or nursing mother, as obviously the individual need varies greatly. The average gain in weight during the gestation period should be approximately 14 per cent of body weight, or 20 to 25 pounds, spaced 3 – 10 – 10 pounds during the trimesters (4, 7). Following delivery the weight falls to a level of 5 to 10 pounds above the starting point, at which level it should remain throughout the lactation period. The basal metabolic rate during the first half of pregnancy remains approximately constant, but during the last 4 months it rises gradually until just prior to the onset of labor it is 20 to 23 per cent higher than at the onset of pregnancy; following delivery the rate falls relatively rapidly to the original level (8). The average woman of sedentary habits requires 2,000 to 2,500 calories per day during gestation, and 2,500 calories during lactation, obtained from carbohydrate, fat, and protein. During the second half of pregnancy, the increased caloric requirement must be adequate to cover the needs of the growing fetus; and later during lactation to furnish milk. Common sources of carbohydrates are bread, crackers, biscuits, cake, pastry, cereals, macaroni, rice, tapioca, sugar, syrup, honey, jams, fruits, and vegetables. Fat is used in the form of butter, cream, lard, crisco, drippings, and salad oil. The appetite usually dictates the intake, which, however, must be supplemented by protective foods except when fruits and vegetables are eaten.

The building foods are of protein and mineral origin. A minimum protein intake of 70 to 100 grams per day obtained from animal and vegetable sources is necessary. Animal protein obtained from meat, eggs, fish, fowl, cheese, and milk should constitute at least one-half the total protein intake. Vegetable protein obtained from cereals, vegetables, and legumes supplement and act as animal protein savers, but as they are inadequate sources of amino-acids should not be used as the sole source of protein supply. During pregnancy the maintenance of a positive nitrogen balance is important, in order to replace losses of the maternal tissues, to furnish adequate nitrogen for the growth of the fetus, and to build up a protein reserve for use during lactation. The protein should be in assimilable form, should contain a selection of amino-acids to spare loss of body nitrogen, and should be accompanied by sufficient carbohydrate and fat to provide an adequate caloric requirement, which in itself will effect a protein saving. This necessity is evident when we consider the relatively greater growth of breasts, uterus, placenta, and fetus itself, during the latter half of pregnancy; moreover, we should remember that, during lactation, the mother should furnish daily 7 to 15 grams of protein for the child alone. A deficiency of protein

[1] Presented before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

may cause nutritional edema, poor muscular tone, lowered resistance to disease, and poor milk supply.

In the pregnant and lactating state, a minimum of 18 milligrams of food iron per day is essential for furnishing the tissue with sufficient oxygen for metabolism. The best sources are liver, kidney, red meat, egg, dried or fresh fruits and vegetables, and molasses. This supply is necessary during gestation for maintenance of the maternal organism, for the growth of the fetus, and for storage in the fetus to provide for the lack experienced during the early months, when milk is the sole food. A deficient maternal intake may provide sufficient reason for the secondary anemia so common during the latter half of pregnancy.

Calcium lack provides the most glaring deficiency in northern Alberta. Its presence in a minimum quantity greater than 1.6 grams per day is necessary for fetal growth and protection of the maternal organism from disease. The logical source is milk, but an inadequacy can be supplemented by cheese, egg yolk, dried fruits and vegetables. A deficiency may result in lowered resistance to disease, muscle pains especially in the legs, dental decay and maternal or fetal rickets.

The phosphorus requirement, 1 to 2 grams per day, is insured by the ingestion of an average supply of animal protein. It is necessary for calcification of bone and nutrition of nervous tissue, and must occur in a definite ratio to calcium to insure normal bone deposition; a deficiency naturally upsets this balance as do physical and psychic upsets, and previous states of nutrition.

An adequate iodine ingestion is secured from water and vegetable foods in districts where it is in sufficient quantity in the soil. We believe the inclusion of one sea-food, fresh or canned, each week provides the necessary supplement. In our province iodized salt is used, but the advisability of this where an adenomatous thyroid exists is questioned.

Sufficient salt is contained in the average diet adequately to satisfy the daily need of 0.5 gram. That there is a distinct surfeit is shown by the average ingestion of 10 to 20 grams per day. We have found that, during the later months of pregnancy, a rapid increase in weight accompanied by edema can be counteracted or at least arrested by a reduction of salt and fluid intake.

The regulating foods are found in water, cellulose, and vitamins. An optimum water balance provides for an efficient circulating medium, aids metabolism, and allows for excretion, without undue storage in the tissues. During the first and second trimesters, an average intake of 2 quarts per day is usually necessary. During the final trimester, and especially when edema occurs, a reduction to 1 quart at least, with some restriction of foods of a high water content, such as melons, tomatoes, and citrus fruits, is necessary.

Cellulose ingestion (bulk) is necessary to insure normal bowel function; and to effect satiety without undue caloric intake. It proves more efficacious in the majority of cases if it is non-irritating. The best sources are fruits, vegetables, and cooked whole cereals.

The very fact of pregnancy itself, and the nutrition of the pregnant woman as a whole, are influenced by the amount of vitamin in the diet (9). Vitamin A is not synthesized by the body, consequently, it must be ingested. But while it is stored in the body in large quantities, yet with the extra demand, unless the intake is constant, the supply is soon exhausted. The best sources are green and pigmented vegetables, egg yolk, milk, butter, and cheese. An added supply diminishes the chance of a morbid puerperium by forming a first line of defense against infection; while a lack of vitamin A may cause early in pregnancy resorption of the fetus, or later promote a greater incidence of premature or stillbirths.

Vitamin B is best contained in the green leafy vegetables, legumes, tomatoes, citrus fruits, nuts, meat, egg yolk, and brewer's yeast. In adequate amounts it stimulates the appetite and influences growth. A deficiency causes an impairment in the neuromuscular control of the gastro-intestinal tract, a decrease in the propulsive speed, and dilatation, resulting in atonic constipation; it may also cause a prolongation of vomiting of pregnancy, and later be a factor causing poly-

neuritis (11). For these reasons an adequate supply insured from the onset of pregnancy will alleviate or in many cases prevent the development of these complications.

Vitamin C is usually found in sufficient amounts in the average diet containing citrus fruits. It is not stored in the body but is readily transferred to the mother's milk, where it assists in infant teeth and bone development. In deficient amounts it may lead to abortion or else to the developing of a debilitated fetus.

Vitamin D influences calcium and phosphorus metabolism. Its distribution in foods is limited; it is found concentrated in egg yolk, fatty fish, fish oils, and to less extent in butter, cheese, and liver. The commonest source is cod liver oil. In optimum amounts it lessens the tendency to fetal rickets; it allows for a greater absorption of calcium from the gut, and hence a greater quantity in the blood stream. A deficiency creates a negative calcium balance with decalcification of bone, and is no doubt a definite factor in the later maldevelopment of primary and permanent teeth.

Vitamin E is widely distributed in foods, in green vegetables, whole cereals, egg yolk, muscle meat, and seeds. At the present it does not seem to have much influence on the pregnancy itself, although its use is advocated as an effective agent in the prophylaxis of habitual abortion.

McLester (10) declares the American people are acutely food conscious and will eat anything that they are told is healthful. Julian Huxley states that, were he able to dictate the food habits of a nation for one generation, he could add one cubit to their stature and double their resistance to disease. Nevertheless, it is established that the diet is deficient in the protective foods, chiefly minerals and vitamins (9). One-third of the average North American diet consists of food prepared from cereal sources, mainly flour, and in its milling excludes practically all vitamins. Of the remainder, meat forms a large part; the roasts, steaks and chops so commonly eaten are not, in the animal, repositories of vitamins. The organ store-houses, liver and kidney, are but rarely eaten. Refining sugar eliminates both minerals and vitamins. The delicate centers of vegetables so pleasing to the palate, obtained after removing the outer leaves, have, in the denudation, been robbed of about four-fifths of their vitamin content. Pasteurizing milk destroys roughly one-third of the vitamin content.

The necessity for adequate vitamin intake thus established should engender in our minds the need for carefully instructing pregnant patients as to their food requirements. It should be almost unnecessary to state that a complete physical examination, including urinalysis and blood count, be performed on each patient, where possible, at her first examination; yet, such a procedure, we are sorry to say, is not the case routinely in general practice. Too often, after the elicited fact of missed menstrual periods, a perfunctory abdominal or pelvic examination is performed and the patient is told she is pregnant (often by herself only too well realized), to be careful of her diet, and to return later. In reply to her inquiry regarding food, she is told not to eat too much meat and to be careful; surely a very indefinite help to a woman whose every part is being definitely upset by this physiological process! Moreover, this may easily be remedied as the doctor is able now to obtain readily and cheaply various pamphlets printed by the federal and dominion governments on diet in pregnancy (5, 6, 12, 13). These yield the requisite information and these he can distribute to his patients if he does not wish to advise them himself.

A simple outline of the protective foods around which the menu should be planned throughout pregnancy and lactation is based on a daily intake of:

a. 1 quart of milk, raw or cooked, supplemented twice each week by cheese.

b. 2 cups of vegetables, 1 fresh when possible.

c. 1 cup of fruit, citrus fruits or canned tomatoes should be included three times a week.

d. 1 cup of cereal, whole cooked, supplemented for 2 or 3 days each month by uncooked grain germ.

e. 1 medium sized serving of meat, fish, fowl or eggs, with liver added once each week.

This will furnish sufficient protein, minerals and vitamins for resistance, well being and growth. Add the amount of bread, potatoes, macaroni, crackers, rice, cakes, sugar, jelly, jam, syrup, cream, butter, and salad oils dictated by the appetite, and regulated by the gain in weight, to supply energy and make the diet attractive and satisfying. Any variation over a period longer than 2 weeks must meet or substitute these amounts.

With this in mind we interrogate the patient as to her appetite, likes, dislikes, and mode of eating. In our zeal for adequacy we must not, however, overlook the fact, as Alvarez (3) points out, that some persons are sensitive to certain foods, and that eating of them may result in any of a host of conditions, ranging from heartburn to convulsions. We must then briefly investigate this possibility, and, if necessary, attempt to modify in form or substitute these offending foods.

If during the pregnant or nursing period the mother cannot take milk we advise milk products. A surprising number of women cannot, or refuse to, take a sufficient supply of milk or its products. In these cases we advise one of the various calcium preparations on the market. This is usually supplemented by the concentrate of vitamin A or D or both. As mentioned before, we regard wheat germ (obtained from any grist mill) as a valuable source of vitamin B. It becomes rancid quickly though and must be purchased in small amounts frequently.

If the hemoglobin is 70 per cent or less of normal, we prescribe an iron preparation, usually Blaud's pills.

During the first trimester certain points are to be emphasized, briefly summed as follows:

1. Repeated small meals throughout the course of the day with the largest meal preferably before retiring; the first a salted cracker or arrowroot biscuit before rising, which act should be performed slowly and circumspectly.

2. Avoidance of combining solid food and more than a minimum of fluid; this prevents that "full" feeling and moreover, makes harder any vomiting which might follow.

3. Avoidance of fried or greasy food and excessive fat.

4. Taking easily assimilable foods, such as, clear candy, honey, sugar in beverages, jello, junket, blanc mange, baked potato, rice, and crackers.

5. If necessary prescribing an additional amount of vitamin B as in pabulum, whole wheat cereal, brewer's yeast, or wheat germ.

During the second trimester, with nausea overcome or past, the ordinary diet suffices. At this time the appetite is usually increased and the temptation is to overeat, with its attendant flatulence or heartburn. Cutting down on the amount taken at one time and avoiding solids and excess fluids together, usually alleviates or obviates these symptoms. A half glass of milk taken 10 minutes before eating, or 2 to 3 drops of oil of peppermint in warm water after eating, also alleviates this distress. A gain of 8 to 10 pounds during this trimester is usually achieved and should not be regarded with alarm.

During the last trimester the diet may remain unchanged, or better, a slight increase in protein during the last month may be encouraged to prepare for lactation. If the gain in weight is too rapid we have found a reduction in the amount of sugars and starches, such as jam, jelly, honey, candy, bread, potato, cake, rich desserts and pastry, will often alone suffice. If that does not suffice or if there is accompanying edema or hypertension, we reduce also the salt and water intake. Our practice in this respect is to advise a fluid intake per day limited to 40 ounces, and avoid using salt at table. If necessary the daily fluid intake may be limited to 30 ounces, and all salt in food preparation omitted. The weight is carefully noted each week or oftener, to check the result of this reduction. This varies slightly with the program outlined by the Committee on Maternal Welfare (2).

Supervision of the diet during the postnatal period is equally important, yet alas, universally neglected. Fluid, calcium, protein, and vitamin B intake should at least be maintained and usually increased. The caloric requirement is approximately 10 per cent greater than during gestation, to cover the energy loss in transforming food energy into milk. An adequate protein intake is most

important, as Adair has shown, in providing a bountiful milk supply. Two quarts of water, 1 to 1½ quarts of milk, an additional serving of meat or its substitutes, wheat germ when possible, all taken daily prove ideal. When, of course, weaning time occurs, these diet constituents are reduced to the previous normal, unless reduction or gain in weight is attempted, when appropriate shifts are made.

The foregoing applies to the woman of average weight. For the woman who is underweight a greater gain is allowed, and her daily ration is increased even to 4,000 calories if necessary. The mineral and vitamin content remain constant. The overweight woman is limited in starches and sugars, with increased mineral and vitamin ration, in order not to reduce, but to keep her weight constant, or at most, secure but a slight increase in weight. These conditions are maintained during the lactation period.

Outdoor patients are treated in a manner parallel to that of private patients. The problem here is threefold: to keep the diet within her budget, to explain to the patient in simple terms the purpose and procedure of the diet, and moreover, to supervise as far as possible her carrying out of the routine.

To that end a member of the dietetic department of the hospital is in attendance at our prenatal and postnatal clinic. To her are referred all new cases, all postnatal cases, and all others that need re-instruction in all or some modification of the diet. With her, the dietitian reviews the budget and presents to her the appropriate routine based on a "relief" expenditure which, in Alberta, averages $1.80 to $3.00 weekly for man and wife. The whole food question has frequently to be straightened out, as often a poor distribution is found to be in evidence. If a greater allowance is deemed necessary it is recommended, and, we are glad to say, is always obtained from the authorities.

If there is too great a gain in weight, if nausea, vomiting, or other early symptoms of toxemia are in evidence, or the milk is failing, the patients are referred to the dietitian for the proper dietary instruction, based, we repeat, on the financial status of the patient. Working thus in close co-operation with the dietitian, we have secured a uniform and more adequate supply of milk, and to date have practically eliminated the severe toxemias, save only those fulminating cases which providence at times thrusts upon us.

This relation of diet to pregnancy and lactation is known in greater part to obstetricians and general practitioners, and yet it is our belief that too little attention is paid to instructing the patient in detail. We are interested not only in the general well-being of the mother, before, during and after delivery, but also in that of her child, a future parent. If then a more careful attention to her diet will enable her to surmount more easily the minor afflictions of pregnancy, and, perhaps, avoid toxemia; will enable her to withstand better a hard and prolonged labor; will enable her better to recover easily and quickly from that labor; and withal, to provide an ample and nourishing supply of milk for her baby, why then that attention is more than justified.

SUMMARY AND CONCLUSIONS

1. We consider the problem of the undernourished pregnant and nursing mother a vital one.

2. We have briefly outlined the food needs, energy, protective and regulating, and have indicated the common sources, and the results occurring in optimum and deficient amounts of each.

3. We have outlined our method of instructing these pregnant and nursing mothers, both in private practice, and, with the aid of the dietitian, in the out-patient service, where the problem of cost is a major one.

4. We believe that more attention to this detail of obstetrical care will yield in return, fewer complications, healthier mothers, and healthier, better nourished babies.

We are indebted to the authors of the references noted, and recommend them for your perusal.

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Discussion

Francis Scott Smyth, M.D., San Francisco: I presume, since I am interested primarily in the health of infants and children, that I am to discuss maternal nutrition as it affects the offspring. We have the slogan "Every child has the right to be well born"; yet the factors involved are numerous, baffling, and frequently beyond our control. Maternal nutrition is one factor which does seem to lend itself to a program of study and control. There has been sufficient evidence to justify correlation of maternal health and certain pathological conditions in the newly born. However, we must allow for the possibility that the effect of faulty maternal nutrition may not be manifest in the offspring until after infancy. Hence, the correlation may not always be apparent.

It would seem obvious that the fetus is entirely parasitic and must depend on maternal metabolism for both food and the excretion of waste products. I do not believe that the literature has been crowded with scientific data on the metabolic needs during human gestation. There are only 10 accurate reports on calcium phosphorus metabolism in pregnancy, and even fewer analyses of fetuses. Far better data on calcium phosphorus metabolism are available in the dairy industry. I do not wish to imply that we lack sufficient information to endorse Dr. Conn's program or that we should wait for further scientific reports before a social application is attempted. I would merely point out that as a field of investigation the metabolism of the gestation period has not been overworked.

But presuming the maternal diet to be sufficient, it is still possible that faulty digestion or elimination will prevent proper nutrition of both host (mother) and parasite (fetus). Recognizing the greater food requirement during gestation, the frequency of vomiting is paradoxical. Hence, as Dr. Conn's program shows, dietary supervision is not merely a question of quantitative intake but must involve quality and distribution. This is provided for by the schedule of small, frequent dry meals to combat vomiting in early pregnancy.

The unique rôle of the placenta deserves discussion. Recognizing it as a barrier between mother and fetus, its selective action is phenomenal since the fetal tissues have a far different requirement from those of the mother. Any failure of placental function cannot but affect the fetal nutrition even though the mother shows adequate nutrition. And the converse also is conceivable that, within certain limits, the fetus may thrive while the mother may show some degree of malnutrition. While we have accumulated data on the pathology of the placenta, there still is much to be learned with regard to its function. The work on the rôle of the placenta in erythroblastosis of the newly born and the recent work of McKhann on immune body and hormone concentration is very stimulating.

Turning next to some of the social problems, I have wondered if Dr. Conn has not encountered some difficulty with regard to follow-up or "policing" the job. For even in our well established "Baby Clinics" the program of which was pioneer in social nutrition, we have frequently seen lip service given to directions but obvious failure in execution. In dealing with adults, I confess an impatience if not despair with the slow process of education and find myself sympathetic with dictatorial power on matters of public health. I think it is safe to say that at present when food is doled out to depression dependents there are better results than when money is given and co-operation regarding dietary advice is optional. But even if temporary control of the diet may be obtained, it should be considered only as a demonstration and cannot

supplant the slow educational policy so necessary for permanent improvement.

Dr. Conn quotes McLester: "The American people are acutely food conscious and will eat anything they are told is healthful." He does not comment further that the barrage of food-faddists and commercial interests tends to drown out the voice of the medical profession. This is not, I believe, because of indifference on the part of the profession, but because it lacks accurate information and methods by which a sensible program may be worked out. Programs such as Dr. Conn has outlined should be welcomed. The excellent work of the food clinic of the Boston Dispensary can be mentioned as a model by which education and method reach both lay and professional groups.

I believe specific programs can be worked out on the basis of our present knowledge even though considerably more scientific data would be helpful. I believe that the baby feeding clinics already demonstrate what may be done by a proper program, and that perhaps one favorable result from the depression has been the opportunity to demonstrate similar results for expectant mothers. Finally, I believe that from the pediatrician's point of view, a closer co-operation with the obstetrician may result in improvement in infant nutrition and perhaps a further reduction in infant mortality.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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FEBRUARY 15, 1936

THE 1935 CLINICAL CONGRESS

THE clinical, executive, and scientific sessions and exhibits at the Clinical Congress in San Francisco and Oakland epitomized clearly the widespread interests and activities of the College and its various committees.

Heralded in the keynote address by the chairman of the Board of Regents on the first evening of the Congress as marking the rededication of the College to educational work among surgeons, hospitals, and the laity, the 1935 Congress accomplished all that was expected of it. The heart of its founder and late director, Dr. Franklin H. Martin, would have been warmed and his confidence in the assured future success of the College strengthened could he have heard the personal tributes paid to his memory and could he have followed the carefully planned constructive actions of the governing board. Again it was proved that the spirit of the College is, as it always has been, a dynamic one, ever looking in advance to meet new conditions arising in the surgical world.

It was appropriate that the rededication of the College to its high purposes should have taken place on new ground. For the first time the Congress was held in the far West and the undisputed verdict has been that the surgeons of San Francisco and Oakland more than justified the selection of their cities as the seat of the 1935 Congress. Under the leadership of Dr. Howard C. Naffziger, they provided for the visiting surgeons such a series of operative and demonstrative clinics as fulfilled one of the main reasons for the foundation of the Congress—an opportunity, for its participants, for postgraduate education of the highest type. The entire medical fraternity of the Bay cities co-operated with the Committee on Arrangements to make this Congress a success.

The clinics covered all of the surgical specialties. Surgery of the eye, ear, nose, and throat was the subject of numerous clinics, and the practitioners of these branches held special scientific meetings throughout the Congress. Perhaps they, more than any others, have utilized the motion picture as a suitable medium for the demonstration of their art.

At the executive sessions it was found necessary to adopt certain amendments to the by-laws of the College to meet new administrative conditions. Judiciary action also occupied the careful attention of the officers. The progress reported by the chairmen of the various scientific committees and of the Department of Hospital Activities is published elsewhere. Much attention was focused on the work of the Committee on Graduate Training for Surgery, in the report of which further study of the introduction of graduate

training in appropriate hospitals and a restudy of the requirements for admission to Fellowship in the College were recommended. At the impressive and colorful Convocation, Fellowship in the College was conferred on 571 candidates, and the incoming president further emphasized the advantages of graduate training.

Numerous sessions devoted to the problems of hospital standardization were largely attended and the progress made in this department was evidenced by the granting of approval to 2,523 hospitals. In spite of the economic stringency to which these hospitals have recently been subjected, it was pleasing to note that their main topics of discussion centered around possible new ways of furnishing better care to their patients. The increasing interest of lay boards of trustees in this work was gratifyingly demonstrated. Approval of 198 cancer clinics, 708 medical services in industry, and many commercial products for hospital use marked further progress.

The large attendance at the evening scientific meetings and the meetings sponsored by the scientific committees on cancer, fractures, and industrial medicine and traumatic surgery was ample evidence that the subjects announced for presentation had been selected with a view to their practical importance to practical surgeons. Guiding principles and specific details in diagnosis, management, and therapy were ably presented, and it was interesting to note the significant fact that a consideration of injuries occupied a relatively more important place than it has in the past when compared with the consideration of diseases.

The participation of the College in the education of the laity on health subjects was recognized by the holding of a Community Health Meeting. The presence of more than ten thousand people at this meeting demonstrated the avidity of the public for such information and their recognition of the College as an authentic source for it. Numerous radio addresses, newspaper articles, and talks before social clubs and high schools extended the scope of this educational influence.

A practically continuous program of surgical motion pictures was presented, and the frequent overcrowding of the large room in which it was held again emphasized the appeal to the surgeons of this visual method of education and furnished convincing proof of the desirability of employing this medium to a still greater extent.

Mention should again be made of the fact that the cornerstone on which the success of the Congresses has been built has been the operative clinics. The reputation of the San Francisco and Oakland surgeons attracted a large registration to this Congress, and the surgeons and hospitals provided a series of daily clinics that has evoked universal expressions of pleased satisfaction from the visiting members of the Congress. California surgeons perhaps as never before have thus contributed to the progress of American surgery.

Not a small part of the educational influence of the Congress was furnished by the technical exhibits which have come to assume an ever increasing scientific aspect from which the surgeons cannot but be benefited.

While strictly scientific exhibits have never received great emphasis at the Clinical Congresses, a number of national organizations with interests in common with the College this year presented instructive demonstrations of their work.

The strictly technical side of their practice has never occupied the attention of the master surgeons to the exclusion of their peculiarly intimate and influential position with refer-

ence to the personal lives of their patients, their relations with their confrères and to the community and the nation. These ethical and civic responsibilities of the surgeon formed the subjects of the addresses of the retiring president and of Dr. Sproul in his Fellowship Address, and the ideas and ideals presented by these gentlemen merit the careful study of all surgeons. They will serve to point the way to a still higher plane for the surgeon in his community life and better enable him "to play a vital rôle in a vital, human relationship." These considerations cannot be too frequently restated if the ideals of the American College of Surgeons are to be translated into accomplished practice.

BOWMAN C. CROWELL.

HOSPITAL STANDARDIZATION

THE eighteenth annual Hospital Standardization Conference of the American College of Surgeons was held in San Francisco during the Clinical Congress, October 28 to November 1, 1935. Speakers at each of the sessions and demonstrations enunciated the practical application of the fundamental principles of hospital standardization. Their viewpoints were especially interesting because they represented mature thought, and an accumulation of facts based on some 34,000 individual surveys of hospitals. A summary of the proceedings of the Hospital Standardization Conference will be published in the March, 1936, *Bulletin* of the College.

The twentieth century hospital is characterized today as an institution in which every man, woman, and child, regardless of race, color, creed, or social status is assured of the best care that medical science can offer to the sick and injured. It is an institution in which the physician, the surgeon, and the specialist are enabled to carry on their professional work in an environment in which they can apply accurate and proved methods of diagnosis and treatment, and in which each member of the medical staff is afforded every opportunity to advance his knowledge of medicine. The twentieth century hospital is a scientific, educational institution.

The term "hospital standardization" if interpreted literally might suggest adherence to a definite pattern, or a tendency to make hospitals more or less similar in plan, construction, equipment, organization, and function. Hospital standardization might also be interpreted as an effort to standardize the professional and non-professional workers in the hospital. But such was never the intention of the initiators of the plan. At no time did they contemplate that the individuality of a hospital should be sacrificed. The officers and field workers of the College, in promoting hospital standardization, have encouraged distinctive service in hospitals through the application of flexible and adjustable guiding principles in the organization itself, and in the service which is rendered to the sick and the injured. They have encouraged group thinking, group discussions, group action, and group review and analysis of end-results. This has not detracted from the individuality of the hospital, for after two decades of hospital standardization one is impressed with the distinctive character of each institution which is on the approved list of the College.

The survey of 3,565 institutions in the United States and Canada registered with the College at the beginning of the year 1935 reveals the following results:

One thousand, six hundred and fourteen of 1,703, or 94.8 per cent of hospitals of 100 beds and over were approved, leaving 89 hospitals, or 5.2 per cent not yet meeting the requirement.

Six hundred and eighty-nine of 1,047, or 65.8 per cent of hospitals of 50 to 99 beds were approved, leaving 358 hospitals, or 34.2 per cent not yet meeting the requirements.

Two hundred and twenty of 815, or 27 per cent of hospitals of 25 to 49 beds were approved, leaving 595 hospitals, or 73 per cent not yet meeting the minimum requirements.

In summary, 2,523 of 3,565, or 70.8 per cent of all hospitals of 25 beds and over were approved, leaving 1,042 hospitals, or 29.2 per cent not yet meeting the minimum requirements.

It must be a satisfaction to every Fellow of the College to know that in 1918, when hospital standardization was inaugurated, 89 hospitals in the United States and Canada met the minimum requirements; but in the 1935 survey 2,523 institutions were accorded a place on the approved list.

It is an accepted fact that in the majority of hospitals the active or attending staff is carefully selected and each man is competent in his respective field. Generally, the professional work of this group is well controlled and supervised, and this results in better medical records, more frequent consultations, a larger volume of laboratory work, and a more thorough review and analysis of the clinical work. If the medical staff is not properly organized, inevitably there is inadequate control. To obviate such a situation the individual members of the medical staff and the heads of departments must be carefully selected, and the chief of staff must be a leader who has some knowledge of medical administrative affairs. The medical staff organization may be "open" or "closed," but it is important in either case that the staff shall be supervised and controlled by its own personnel. The advance of scientific, professional efficiency of the hospital is assured if the chief of staff and the heads of the clinical departments recognize and assume their responsibility.

The weakest link in medical staff organization today is that very large, loosely organized, and generally uncontrolled group—the so called courtesy staff. It is imperative that the administration of the hospital, through its medical staff organization, shall bring this group under better control, even though it may mean curtailment of revenue. Every Fellow of the College and every member of the active medical staff should assume his share of responsibility for the work of the courtesy staff.

One of the inherent though intangible benefits of hospital standardization is its educational value to the members of the medical staff. When a physician is graduated from college he has a great mass of technical knowledge. This knowledge must never become static; it must be broadened, adjusted, or even displaced. This may be accomplished through clinical experience in a hospital, through the preparation of comprehensive medical records of patients, through the proper use of the adjunct facilities, and particularly through the clinical pathological conferences in which a doctor works in close association with his colleagues in an atmosphere of continuous, reciprocal postgraduate education. Two decades ago when hospital standardization took root in America, less than 500 staff conferences were being held annually for the systematic review and analysis of the clinical work. In 1935 more than 40,000 staff conferences were held, with an aggregate attendance of 800,000.

The advancement of medical science depends largely on the accuracy of medical records. Every progressive hospital today recognizes the value and necessity of medical records, filed in an accessible manner, readily available for restudy, reference, or scientific research. Every physician, surgeon, and specialist privileged to work in a hospital should consider it his individual responsibility to provide a complete medical record of every patient who is entrusted to his care—a medical record which contains sufficient data to justify the diagnosis and to warrant the treatment and end-results. The need for a "medical records consciousness" is apparent in every

institution, but this consciousness cannot be successfully acquired until the medical records are used extensively. All too frequently the medical record room is a "cemetery" where the records of patients are permitted to rest, undisturbed, in peace. Continuous individual and group study of medical records is essential to the advancement of scientific knowledge.

Through hospital standardization, increasing attention has been directed to adjunct facilities, particularly to the clinical and X-ray laboratories. The greatest advance in these services in recent years has come through the advent of the approved pathologist and radiologist, and the registered technician. Because of the limited number of qualified pathologists and radiologists, hospitals have been encouraged to share the services of major specialists in these fields. There are other adjunct diagnostic and therapeutic departments which are of value to scientific medicine, but each must be under a qualified medical specialist in the respective field if the services are to be properly administered.

The problem of the division of fees is one of the earliest and most difficult with which the American College of Surgeons has had to deal. Since the inception of hospital standardization the College has whole heartedly and vigorously fought this practice in which the monetary rather than the merit aspect is the prevailing influence—the buying and selling of patients on a commission basis. Owing to the difficulty of obtaining tangible evidence, it is impossible in every instance to take effective steps to combat the division of fees, but even well sustained rumors have been considered sufficient grounds for lowering the rating of a hospital or withholding approval. The College has exposed this practice through every possible means, and the blatant, vicious types of fee splitting have either disappeared from communities or have been driven to cover; but it is admitted that the practice still exists. A hospital is not conforming to the minimum standard if it knowingly harbors fee splitters, or even those about whom rumors of fee splitting persist. The College must continue its efforts to abolish fee splitting; and in this as in every activity of the College each Fellow has a direct responsibility. If the Fellows of the College themselves would assume leadership in their respective communities and educate the public as well as the medical profession at large, the desired result could be readily attained. In a small rural community where fee splitting was the general practice, a campaign was launched by the four Fellows of the College, first in the medical profession itself and later through a campaign which was carried to the public. Soon the practice was abolished, and today there are three accredited hospitals which serve the public in that community.

Is it possible for every hospital which exists today to become standardized or to meet the minimum requirements? According to the latest hospital directory of the American Medical Association, there are 6,634 registered hospitals in the United States, of which 2,281 meet the minimum standard. Some of the hospitals which are not on the approved list of the American College of Surgeons will not meet the minimum requirements because of lack of interest, or because of an unfortunate background. It is to be regretted that a hospital can come into being today in almost any community merely by expressing good intentions and giving reasonable assurance of the observance of the laws of sanitation and of freedom from physical hazards. Unqualified hospitals will be eliminated only when every hospital is required to meet minimum standards of construction, equipment, organization, and personnel before a license is granted. After years of study and preparation, volun-

tary organizations have laid down minimum standards; now it is the responsibility of the governing bodies to see that these standards are enforced if the best interests of health and human welfare are to be served.

Hospital standardization requires the whole hearted co-operation and support of every Fellow of the College. It would be a noteworthy achievement if the College could establish its ideals and objectives in every institution which cares for the sick and injured in the United States and Canada. There are many notable examples where Fellows of the College in their respective communities have been responsible for promoting hospital standardization in a distinctive manner, and it is hoped that every Fellow will lend his aid in furthering the hospital program of the College.

Approved hospitals have had a large part in elevating the standard of surgery, which is the announced object of the American College of Surgeons. But the facilities of approved hospitals have not yet been utilized to the fullest extent in training the younger surgeons. This is a subject to which the College is giving special attention at this time, looking toward the establishment of three to five year residencies in general surgery and the specialties in many of the major hospitals.

MALCOLM T. MACEACHERN.

PRESIDENTIAL MEETING, CONVOCATION

THE CONSCIENCE OF THE SURGEON[1]

ROBERT B. GREENOUGH, M.D., F.A.C.S., BOSTON, MASSACHUSETTS

IN accordance with a wise provision of the by-laws of the American College of Surgeons, the president-elect serves a novitiate of one year. During this period it is his duty to make himself familiar with the details of organization and administration of the College before he is inducted into office and becomes in fact the president of the College with the duties which are definitely prescribed for that office. At the end of his year of experience as president, it is again his duty and his privilege to bring to the attention of the Fellows such suggestions and recommendations as appear to him important for the further advancement of the College. In fulfillment of that duty, I stand before you tonight to discuss briefly a matter to which one of my predecessors referred a few years ago as one of the "intangibles" of surgery—the conscience of the surgeon.

With the extraordinary advances in surgery which have taken place in the past twenty years, it has been made possible for us to increase enormously the efficiency of our service to mankind. These additions to our material resources, however, have tended I think to divert attention somewhat from the more spiritual and moral aspects of the practice of surgery which have been in the past, and must always be in the future, the guiding principles of our service to humanity, if we are to continue to retain the respect and the devoted appreciation of the community which has been accorded us in the past.

Conscience is defined as "moral sense" or "a sense of right and wrong." To this may be added "conformity to one's own sense of right in conduct, or to that of the community." There has thus become attached to the concept of conscience, the idea not only of ability to discern the right, but to act accordingly, and with this has come a sense of responsibility to others and to the community as a whole. Possession of a conscience becomes thus one of the finest attributes of human character and distinguishes the higher civilizations from that of man in the primeval state.

The science and art of medicine is of necessity so little understood by the laity that they are obliged to entrust their lives and their welfare to the physician rather upon faith in his character and reputation than upon actual experience of his abilities. Thus, conscience becomes one of the most important elements in the character of the physician. Especially is this true as regards the surgeon, for his activities are carried on largely in the seclusion of the operating room and often only his colleagues and his assistants are in a position to judge intelligently whether his ministrations to the sick and injured are as efficient as the existing state of surgical knowledge and resources will permit. It is this fact that seems to justify a review of some of the features of the practice of surgery, which require a keen conscience on the part of the surgeon and a definite sense of responsibility to his patient, to his hospital, to his colleagues, and to the whole community.

We must start with the definite understanding that physicians and surgeons are not born as supermen, they merely have to become so. They are influenced by the same considerations of ambition, selfishness, greed, and jealousy as afflict other human beings. As children we are obliged to learn, by our training, by the example and counsel of our elders and instructors, and by the standards of ethics and morals of the community in which we dwell, as well as by our innate sense of justice, to resist these impulses with more or less success, and to determine our conduct accordingly that we may play the part which is allotted to us in modern civilization. Such training brings to the medical schools a group of young men, not greatly different from others who have prepared themselves to study for law, business, architecture, or other professional careers. From the beginning of the medical school course, however, and especially in the last two years when the student comes more in contact with clinical work in hospitals, he begins to appreciate the peculiar relation of personal responsibility to his patient, which the physician must be ready to accept as the first and foremost condition in the practice of his profession.

In school and hospital, the medical student's work is carried out under supervision. He is able

[1]Address of the Retiring President, presented before the Clinical Congress of the American College of Surgeons, San Francisco, October 28, 1935.

to observe the responsibility which his surgical instructor assumes when he entrusts an operation, a dressing or any surgical procedure to the neophyte. He realizes how closely his work is observed and criticized or commended, and how every precaution is taken to ensure that difficult operations and procedures demanding considerable surgical skill and judgment, shall not be entrusted to the beginner until actual experience has demonstrated his qualifications for the appointed task. This is the period in the student's training when his surgical conscience begins to be developed, and it is of vital importance to the success of its development that this sense of responsibility to the patient should be demonstrated and respected by the individual members of the hospital staff under whom he obtains his training. A low standard of ethics on the part of a hospital staff is inevitably reflected in the lowering of the moral sense of graduating internes, and in a short time readily debases the ethical standards of the practice of medicine and surgery in the whole community.

On completion of his interne service, or if he takes the longer period of training as a resident, which is coming to be recognized today as a necessary qualification for specialization in surgery, at the end of his resident service, the young surgeon qualifies by passing the state or national board of registration, and obtains a license to practice medicine. This is today an all inclusive license and permits the physician to practice medicine, surgery, obstetrics, and, indeed, any of the specialities for which he may consider himself qualified. Here again his conscience is his only guide. We seldom encounter today, however, instances of willful disregard by the surgeon of the dictates of conscience in attempting to undertake operative procedures for which he is in no way qualified. This fact is due in no small degree to the educational and disciplinary measures instituted by the American College of Surgeons, and to the doctrine of staff responsibility which has been so vigorously promoted by the department of hospital standardization.

The apprentice system of education is ideal in its application to the career of the junior surgeon, provided always that the surgeon with whom the apprentice works is ethically, as well as surgically, qualified to give the desired training. The association between the competent, conscientious surgeon and his junior assistants may be one of the most delightful and stimulating of human relationships. Unfortunately, not all surgeons are sufficiently altruistic to be able to withstand jealousy of the highly competent assistant or associate who is beginning to stand on his own feet; nor are all assistants and associates sufficiently loyal to their preceptors to avoid the suggestion of competition as they approach the inevitable end of their apprenticeship. There is in this case the need of a keen conscience and an innate sense of justice and fair play on the part of the surgeon, as well as of the assistant or associate.

In relation to his patients, perhaps the most vexing problem to the surgeon is provided by the judicial consideration of the indications for or against operation. The patient is often referred to the surgeon by one of his medical consultants with a diagnosis made and advice to submit to operation given. Shall the surgeon permit himself to be made the mechanical assistant of the attending physician? Not at all! The full responsibility passes at once to the surgeon when he accepts the patient. He must convince himself that the circumstances warrant the operation; that all reasonable methods to confirm the diagnosis have been made; that there are not sufficiently important contra-indications to prevent the operation, and that it is in the best interest of the patient that the operation be performed. Here again the surgeon must consider himself in the light of a trustee of his patient in surgical matters and act accordingly. The reputation of being easily influenced to operate, is one which no surgeon can afford to sustain, and his conscience alone should serve to protect him from this accusation.

Surgical internes and residents in the hospital receive their training in the whole field of general surgery, and this, indeed, is as it should be. As his experience develops, however, he finds that one or more of the special fields of surgery appeal especially to him, and he devotes himself to carrying his knowledge of these special subjects to a higher degree of development than in other fields. To this end he may attach himself temporarily, at least, to one or more of the special clinics and services which have been developed of late years in many of our larger hospitals. His general surgical work must not be sacrificed, but a certain amount of special knowledge is an asset of enormous value to the young surgeon who is starting in general surgical practice, and brings him opportunities for co-operation and assistance to older men that are of the greatest help in establishing him as a useful and respected member of the surgical community. He may in this way also readily lay the foundation for such original and investigative work as still happily remains the supreme ambition of the members of the medical profession, in the hope of making some worthy contribution to the advancement of medical science.

The American College of Surgeons seeks to indicate, by admission to its Fellowship, that by training and by experience its Fellows are qualified to practice either general surgery or one of its designated special branches, and that the ethical standing of the surgeon and the reputation he holds among his colleagues is above reproach. The world advances, however, and the surgery of today is very different from that of twenty years ago. The training and experience which was sufficient for qualification as a surgeon in 1912 must be considered inadequate today. It would be a sad commentary on the wisdom of the founders of the College if its by-laws were not so worded as to permit the qualifications for Fellowship to advance with the progress of surgical science. Fortunately, this is the case, and it is and has been the duty of the College, through its credentials committees, to raise the standards of admission to Fellowship in the College as the years go by.

Surgery is taught in our medical schools as one of the two great departments of medical science. Every graduate in general practice is expected to know the essentials of surgery and in an emergency, where more experienced surgical aid is not available, is expected to do the best he can for the patient. Such circumstances justify attempts to perform surgical operations by the general practitioner which would not be tolerated under other circumstances where better qualified surgical experience was accessible. Here the conscience of the physician plays a most important rôle. He must place his services at the disposal of the patient, and he must use such judgment and such skill as he may have to meet the emergency until more expert service can be procured. In doing this, he must be guided by conservatism and must have the interests of the patient so at heart that he unavoidably is forced to view the problem with unbiased appraisal of his own abilities; a proceeding in which his conscience alone can guide him to a correct decision. The same situation arises when the surgeon, trained and qualified in general surgery, is faced with an operation or a method of treatment which requires special experience or equipment not available in his community. If the situation is an imperative emergency, he must do the best he can with what he has. If not, his conscience will make him see the advantage to the patient of obtaining more expert aid by sending the patient elsewhere, or bringing in some more qualified consultant.

The subject of surgical fees is again a question in which the conscience of the surgeon must play an important part. It is a well established axiom that maximum fees for surgical service can be paid only by the very well-to-do, and that the greater part of the surgeon's work must be performed either gratuitously, as is customary in free hospitals and clinics and too frequently also in private practice, or at fees far below the maximum amount accepted in the particular community as reasonable and proper remuneration for the service rendered. Many medical societies have attempted to establish fee tables for medical and surgical services, but the spread between maximum and minimum fees is usually so great as to make its application to the individual case extremely difficult. It is undoubtedly true, also, that the standards for medical and surgical fees in one community differ greatly from those in another, and hard and fast lines can rarely be drawn without consideration of the local standards.

In general there is a disposition on the part of the public to consider the surgical laborer worthy of his hire. It is usually only when the patient is for some reason dissatisfied with the service given, or when he comes to the conclusion that the fee charged is exorbitant, that complaint is made. These difficulties can be avoided to a great extent, if financial considerations are discussed beforehand, but there seems to be an almost unaccountable reluctance to adopt this plan. The surgeon hesitates to introduce this subject lest he be thought mercenary in his motives, and too often patients fail to make inquiry about expenses, in the assumption that the operation must be done in any case and, at the moment, the matter of expense is to them of least importance. Since there is always of necessity some discussion, as to hospital accommodations, however, the subject of expense of surgical services can readily be brought into consideration. From this point of view, it is the patient's financial welfare rather than that of the surgeon which is under discussion, and mention of surgical fees beforehand is not likely to be misconstrued. If this practice were more often followed, complaints of overcharging would be greatly diminished. In this connection, also, it should be emphasized that it is by no means always the largest fees which lead to criticism but rather those which, while justifiable to the average patient, represent to the individual of moderate means, a sum out of all reasonable proportion to his resources. A system of medical practice under which people may be forced to mortgage their property and to expend for necessary medical or surgical service a great part of the resources which they have accumulated in years past to safeguard their dependents as well as their own declining years, can be fairly criticized. Free or

partial payment hospital service, adequate, if not luxurious, is available today in all of the larger communities and in many smaller and less thickly settled districts in this country for those who deserve such treatment. The medical profession has always been, and will continue to be, ready to give its service gratuitously, if necessary, or at reduced fees to those in need. To avoid injustice, however, plain talk is necessary and false pride, either on the part of the surgeon or of the patient, must be avoided. Luxuries should be eliminated. Consideration of the essentials is the first necessity. The conscientious surgeon will make this clear to his prospective patient. This applies not only to the straightforward discussion of the patient's resources and of his financial obligations and responsibilities as well, but it involves also the necessity for the surgeon to consider that he is acting as the trustee of the patient in advising him to obtain such type of hospital accommodation as is suited to his means. The desire of family and friends to mitigate as far as possible the dangers and discomforts of surgical hospitalization leads many to assume expenses which are quite unnecessary, for hospital accommodations, for special nurses, for the services of special consultants and, indeed, for many special and expensive laboratory methods of diagnosis, which, while occasionally necessary, are often quite superfluous in routine cases. The conscientious surgeon will seek to protect his patient from unnecessary extravagance along these lines, just as surely as he endeavors to protect him from the dangers of anesthesia and of sepsis in the operating room.

In his relations with other physicians and with other surgeons, the surgeon's conscience must be keenly alive to the necessity of avoiding injustice to others; as indeed he desires to escape injustice to himself. The "Golden Rule" is still an adequate guide to conduct for the surgeon as for other individuals in the world today; although there are those who maintain that of late years, under the stress of competition and depression, its observance is not as popular as it used to be.

The physician in general practice selects one surgeon rather than another to whom to send his patient, primarily because he has confidence in the chosen surgeon's ability and integrity. It is unthinkable that such considerations should be thrown in the discard, and the selection of the surgeon made because of financial considerations offered by the surgeon in the form of splitting fees. Such buying and selling of patients requiring operation in the past, has been a grave reproach not only to the surgeons and physicians who so debase their profession, but to the communities in which these grave abuses of professional honor have existed. The campaign which the American College of Surgeons has carried on to eliminate this pernicious practice is one of its greatest achievements, but is is undoubtedly true that in certain localities fee splitting still exists, and the College cannot rest until the evil is eradicated for good and all.

In his relations with his consultants the surgeon must so conduct himself as to protect the interests of the physician as well as of the patient. Here lies a divided responsibility, and circumstances may make it impossible that both interests be adequately protected. It is the patient's welfare, however, which must be paramount, and that of the physician must give way if the two are definitely in conflict.

If the physician is seriously at fault this fact must be acknowledged, but explanation of such extenuating circumstances as are present should be given due consideration, and every effort should be made to protect the physician from unjust and undeserved criticism. Many suits for malpractice owe their origin to hasty and often unjustified criticism of a physician by other physicians who are often ignorant of the actual facts and who base their conclusions on insufficient or incorrect evidence supplied by the patient or his sympathetic friends.

The relation of the surgeon to his colleagues and surgical competitors gives ample room for the conscience to determine right and wrong behavior. It is true, of course, that there is intense competition for surgical practice, not only in smaller communities but in larger cities as well. The preparation and presentation of papers at medical meetings is recognized as the only legitimate form of "advertising" of medical or surgical proficiency, although hospital appointments, teaching positions, and medical society office and committee work, all undoubtedly serve the purpose of making the surgeon better known among his colleagues. It is true that even this legitimate advertising may be overdone. The surgeon who is prolific in medical literature, especially if his communications are not impressive, acquires a reputation which in the long run defeats his purpose by exposing him to some good natured ridicule from his colleagues and competitors. Beyond this point, however, the medical code of ethics does not permit the surgeon to advertise his accomplishments, and especially must he avoid any direct approach to prospective patients by newspaper or other publicity which features his individual professional accomplishments. The medical code of ethics, which forbids such practices, is

looked upon by many of the laity as an antiquated and unnecessary custom, but they fail too often to appreciate that it is devised, not for the protection of the physician, but in the interests of the public.

Without this code, the public would be exposed to the same exploitation by unscrupulous physicians, as that to which they are now subjected by advertisements and high pressure radio publicity methods of quacks, cultists, and the manufacturers of patent medicines and commercial remedies. The physician who is competent and proud of his profession avoids even the semblance of advertising and is vigorous in the enforcement of the code of ethics to which we all subscribe. This code in no way prevents a patient from changing from one physician to another if dissatisfied, and in no way prevents the physician from accepting a patient who has been in another physician's care. The only necessity is that this be done openly and aboveboard, and that a definite understanding of the change and of the occasion for it be had by both physicians. The character and temperament of the physician or surgeon is so significant a part in the patient's choice of one or another medical attendant, that no reflection upon the physician's professional competency is necessarily involved in such a change, and often the physician who is relieved of responsibility in a given case is quite as pleased as is the patient when such a change is properly brought about.

The most disagreeable duty which falls upon the surgeon is that which results from his responsibility to the community and to the medical profession as a whole: to take his part in the protection of the public from incompetent or unworthy members of his own profession. In such cases, whether it be in a court of law or by participation in a trial board, the surgeon's duty to his colleague must give way before his duty to the community and to the profession as a whole. Here again his conscience must determine his action, while his professional judgment must be as impartial as he can make it.

I have dwelt upon some of the more difficult problems which beset the surgeon in the ethical practice of his profession, but there are countless more which occur to trouble him from day to day. The pledge to which we all subscribe when we are admitted to Fellowship in the American College of Surgeons, covers in broad terms many of the matters I have set before you tonight. It is well that we should ever bear in mind the terms of this pledge which we have taken, since they are helpful in the determination of our conduct from day to day. Let us remember always that, however great our knowledge or our technical skill, it is the application of that knowledge and skill to the service of the community that is required before it becomes of value. It is the character of the surgeon and his moral sense of responsibility, in other words his conscience, which finally determines the effectiveness of his service to the community and the respect which he himself and the science and art of surgery to which he devotes his life, is accorded by the public.

THE AMERICAN COLLEGE OF SURGEONS AN EDUCATIONAL INSTITUTION[1]

A Tribute to Franklin H. Martin

GEORGE CRILE, M.D., F.A.C.S., Cleveland, Ohio

ORIGIN AND UNDERLYING PRINCIPLES

IF one were to ask the American College of Surgeons whether it would not be well for it to enter into educational activities, such a question would be as naive as it would be to suggest to Harvard University that in view of its buildings, equipment, and personnel, it would be well for the University to become an educational institution.

In the unparalleled development of undergraduate instruction during the years prior to the founding of the American College of Surgeons, the undergraduate faculties in America had neither the time, the staff, nor the facilities to take over postgraduate instruction on a large scale. Forty years ago the ambitious surgeon was confronted by a dilemma: either he must go on as best he could, "on his own," or else he must go abroad, where better postgraduate opportunities could be secured.

For many years prior to the founding of the American College of Surgeons, there had been an insistent demand, particularly by members of the special surgical societies, that some organization be founded whose prime function would be the elevation of the standard of surgery in the United States and Canada. This demand had come in particular as a result of the organization in 1903 by a small group of surgeons of the Society of Clinical Surgery, which, as its title suggests, recognized the difference between teaching of the theory of surgery and training for the practice of surgery. The programs of the meetings of the Society of Clinical Surgery in America consisted of operative and dry clinics and of laboratory demonstrations. In keeping surgeons abreast with surgical progress, it was at once obvious that the value of the demonstration of the practice of surgery far exceeded the presentation of the theory of surgery in papers.

This new pattern of mutual teaching evoked such enthusiasm among the members of this society that similar groups were organized in various fields of medicine and surgery and in the specialties, and Franklin H. Martin envisaged the possibility that this principle could be made available on a large scale to surgeons everywhere.

Using his journal, Surgery, Gynecology and Obstetrics, as a means for organizing and publicizing such a movement, he founded in 1910 the Clinical Congress of Surgeons of North America, the first meeting of which was held in Chicago, November 7 to 19, 1910.

The program of the Chicago Congress consisted of clinics and demonstrations supplemented by evening addresses upon the surgical problems of the day. That this educational principle met a universal need was attested by the facts that this first Congress was attended by 1,300 surgeons; that at the end of the first week of the Congress an invitation was received from the medical profession in Philadelphia to hold the second Congress in that city; and that before the conclusion of the Philadelphia Congress in 1911, many delegations were urging that New York have the Congress in 1912.

For some time previous to the inauguration of the Clinical Congress, the need of an American College of Surgeons had been seen and discussed, and the insistent demand for such a permanent organization came to a focus at the Clinical Congress in New York in 1912. It was largely through the personal leadership of Franklin H. Martin that a committee was formed to formulate a plan of organization, and that on November 25, 1912, a charter was granted by the State of Illinois for the establishment of the American College of Surgeons. The American College of Surgeons was patterned after our federal government and the government of the Dominion of Canada, as it recognized states and provinces as units in the organization.

A board of regents, a board of governors, a credentials committee for each state and province, and a Central Credentials Committee were established, and Dr. Franklin H. Martin was appointed director general. The committee which drafted the original by-laws, rules, and regulations consisted of the following: Franklin H. Martin of Chicago, Edward Martin of Philadelphia, Emmet Rixford of San Francisco, John B. Murphy of Chicago, Rudolph Matas of New Orleans, Albert J. Ochsner of Chicago, Charles H. Mayo of Rochester, Frederic J. Cotton of Boston, George Emerson Brewer of New York, John M. T. Finney of Baltimore, Walter W. Chipman of Montreal, and George Crile of Cleveland.

[1]Annual Oration on Surgery, presented at the Presidential Meeting of the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

The original roster of Fellows, that is, the Founders of the College, included 546 surgeons of Canada and the United States.

The first president of the College was John M. T. Finney of Baltimore, and succeeding him in the earlier years we find such names as William J. and Charles H. Mayo, George E. Armstrong, John B. Deaver, Harvey Cushing, Albert J. Ochsner, Rudolph Matas, and Walter W. Chipman.

Such names as these give testimony of careful organization, of representation from various parts of Canada and the United States, and of various types of surgery. Throughout these years the leaders in undergraduate education and the leaders in the practice of surgery—men experienced in organization—have made up the governing groups —the Board of Regents, the Board of Governors, and the various committees. Each has left his impression, and the result is seen in the present, not static, but continually evolving pattern of the College.

To achieve the purposes of the College, land, buildings, and endowments had to be provided. Realizing this, many of the Founders and of the subsequent Fellows of the College became life members of the College by the payment of $500 each, the amount thus contributed constituting a substantial part of our capital fund.

Although the educational activities of the American College of Surgeons started at once after its organization, for 7 years it had no home of its own. In 1920, through the leadership of Franklin Martin, in association with a group of Fellows of the College and of citizens of Chicago, the handsome headquarters and valuable land at the corner of Erie street and Wabash avenue was acquired, and later the beautiful Murphy Memorial building and library was presented to the College by the family and friends of the late John B. Murphy. In 1928 a plot of ground was purchased by the College at the corner of Rush and Erie Streets as a site for the future Hall of the Art and Science of Surgery. These properties have an approximate value of $1,250,000.

ADMISSION REQUIREMENTS

Every educational institution has certain requirements for admission, and the status of the institution in the educational world depends largely upon its adherence to those requirements. To this end the American College of Surgeons has established a credentials committee in each state and province which is made up of Fellows of the College who are elected by vote of all the Fellows from the respective state or province. These credentials committees have set up standards for admission to the College and are the first to pass upon the qualifications of a candidate for fellowship. These standards are based upon the actual fitness of the candidates by training, character, and experience as these qualities have been evidenced in their daily work and in their daily contact with Fellows of the College in the hospitals in which their work is being done. These committeemen are themselves leaders and know best how to judge the qualifications of the men who are practicing surgery in their respective territories. Each state and provincial credentials committee holds one meeting a year, when the applications for fellowship of the respective state or province are considered.

The strength of the American College of Surgeons lies largely in the fine, impersonal judgment of the local credentials committees which constitute a group of more than 900 leading surgeons throughout Canada and the United States who are serving this important purpose. In this unheralded group is vested the primary responsibility for the numbers and quality of the Fellows of the College.

In addition to the recommendation by the state and provincial credentials committees a "written examination" is required in the form of a report of 100 histories of major operations—50 histories of operations of the candidate's own cases and 50 of operations at which he has assisted or for which he was the responsible surgeon. These histories must be submitted to the committee on history reviews, which is comprised of members of the surgical divisions of faculties of medicine. Its members meet weekly during several months of each year. They have served without pay for years and over a million case histories have been reviewed by this committee of the College.

The standards set by credentials committees and by the committee on history reviews have been steadily raised, increasing emphasis being laid upon the length and adequacy of the candidate's training, as the College encourages long term training in surgery.

The recommendations of the state or provincial credentials committees and the findings of the committee on history reviews are then considered by the central credentials committee whose recommendations are finally acted upon by the Board of Regents, individually and collectively. Upon this Board rests the final responsibility for determining the candidate's eligibility for fellowship.

It is apparent that this method of selecting the candidates by the leaders in the profession in the states and provinces, in which they live and practice, provides a safer and more accurate criterion from the educational point of view than the results of an examination of textbook knowledge which would give little evidence of the fitness of the candidate to assume the high responsibilities of the practice of surgery.

It does not seem to be a question of how many the College should admit to fellowship but rather of how many are ethically and professionally qualified for fellowship. If the College is to carry out its purpose it should aim to admit to fellowship every surgeon who is ethically and professionally qualified and who is recognized as a safe and efficient surgeon in his community. This will stimulate others to attain the standard set by the College and is the most effective way to raise the standard of surgical competency.

In other words, the American College of Surgeons is not a restricted society for those who have achieved a position of exceptional merit; that office is filled by a number of special societies, membership in which is eagerly sought and is conferred only as a special recognition of merit. The membership of the American College of Surgeons, on the other hand, is composed of surgeons who have proved that they are safe surgeons from the standpoint of the patient and who wish to participate in a program for the elevation of standards of surgical and hospital practice.

One sometimes hears the criticism that there are men in the College who do not merit membership for one or another reason. This same statement may be made of every organization that exists, of every church, and of every club. In our organization we believe that this does not detract from the innate merits of the fundamental principles of the organization. On the other hand, we have all the barriers that can reasonably be set up to prevent the ingress of the undesirable candidate, and the judiciary committees in each province and state are constantly having cases referred to them for investigation of rumors regarding individual Fellows.

The executive committee refers the findings of the judiciary committees to the Board of Regents for final action. From time to time Fellows are expelled from the College for conduct which is injurious to the good order, peace, or interest of the College, or derogatory to its dignity, or inconsistent with its purposes; and though these cases are not publicized, the names of such individuals are no longer included in the roll of Fellows.

HOSPITAL STANDARDIZATION

The very first educational problem that presented itself was that of hospital standardization. This involved an educational program for the vast network of hospitals in the United States and Canada. The number of hospitals which have now reached or exceeded the minimum standard is 2,523. The value of their land, buildings, and endowments is approximately $3,500,000,000. The number of surgical operations performed annually in the hospitals of Canada and the United States is approximately 2,500,000.

Hospital standardization is distinctly an educational program. It has affected not only the members of the hospital staffs but the general public as well. The public by this effort to promote better hospitalization has come to look upon the hospitals as the most important agents in the promotion of health and the advancement of human welfare.

The hospital information and service department of the College is a part of this great educational enterprise as through this channel hospitals may secure authoritative and complete information concerning problems of planning and construction, organization, administration, management, and standardization.

The hospital standardization program which has extended over 18 years has involved over 34,000 surveys, including more than 3,600 hospitals. The major rôle in this colossal task has been played by the associate director, Dr. Malcolm T. MacEachern. In all of this work the College has been aided by the great medical and hospital organizations, including in particular the Catholic Hospital Association, originally under the leadership of the Rev. Charles B. Moulinier.

DEPARTMENT OF CLINICAL RESEARCH

To further its educational program, the College of Surgeons has organized departments in the form of committees to each of which a specific field of activity is assigned. The work of these committees is correlated and promoted by the associate director, Dr. Bowman C. Crowell.

Thus there is the Committee on the Treatment of Malignant Diseases organized by our retiring president, Dr. Robert B. Greenough, who was succeeded by Dr. Charles A. Dukes, the present chairman. The prime purpose of this committee is to make the benefits of contemporary knowledge of cancer available to every surgeon. Under its auspices 250 cancer clinics have been surveyed among which 198 have been approved. The College has information concerning 116 other cancer clinics which are in some stage of formation.

There is the Registry of Bone Sarcoma, originally established and presented by Dr. E. A. Codman, which investigates and publishes criteria for establishing the diagnosis of malignant bone tumors. The Registry now contains approximately 1,900 complete case records and an increasing number of 5 year cures is being reported annually. The nomenclature has been made uniform and the procedure for accuracy in diagnosis and effectiveness of treatment has been widely disseminated. Dr. Dallas B. Phemister is the present chairman of the Registry.

There is a Committee on Fractures which, first under the successful chairmanship of Dr. Charles L. Scudder and now under Dr. Frederic W. Bancroft, has established a standard for minimum equipment for fracture treatment in hospitals. Its constant effort is to stimulate interest in and to improve the treatment of fractures. The committee has established better means of caring for the treatment of fractures in hospitals and has promoted a national program in first aid and transportation of the injured.

There is a Committee on Industrial Medicine and Traumatic Surgery of which Dr. Frederic A. Besley is chairman. This committee reports an increasing interest in this department of the educational program of the College on the part of leading industries. A minimum standard for medical services in industry has been established, and 1,314 industries have been surveyed of which 712 have been approved. The great importance of these two committees—on fractures and on industrial surgery—is emphasized by the fact that last year in the United States there were 16,000 deaths from industrial accidents and 36,000 deaths from motor vehicle accidents. The total disabling injuries in the United States in 1934 amounted to 9,921,000.

There is the recently established Medical Service Committee of which Dr. Robert B. Greenough is chairman, the purpose of which is to formulate general principles on medical economics for the ethical guidance of Fellows of the College.

The work of the Committee on Medical Motion Pictures, under the chairmanship of Dr. J. Bentley Squier, has been of important educational value. This committee reviews medical motion pictures, thereby stimulating the production of such films along proper ethical and technical lines. Medical motion pictures can be a valuable adjunct in the teaching and dissemination of medical knowledge. To this end the committee has outlined an extensive program covering the production of important films pertaining to fundamental sciences, medicine, surgery, and various specialties, hospitals, nursing, and the promotion of health. Through special committees on the review of films, the College has examined many hundreds of films each year, approving those which are of high educational value for medical students and physicians. Through this means the value of the motion picture from the educational standpoint is fully realized.

A Committee on Graduate Training for Surgery, under the chairmanship of Dr. Samuel C. Harvey, has recently been organized. The need for such a committee might be questioned since all activities of the College are concerned with educational problems. This committee, however, has been appointed to study graduate training for surgery. Years ago the long-time training of internes in surgery was adopted at Johns Hopkins Hospital, but this offered a special opportunity to a limited number of men. This principle, however, has been extended to other hospitals. It is now expected that a larger number of hospitals will enter into this plan by which more men expecting to enter the field of surgery and the surgical specialties may have longer and more efficient training.

Through the Library and Department of Literary Research, instituted in 1921, the College is able to stimulate educational research among clinicians everywhere. The extensive library with its thoroughly trained staff makes it possible for the College to comply with requests for information on all medical and surgical subjects by providing abstracts, bibliographies, reports of researches, and package libraries in all languages from available literature. Through proper organization of the accumulation of valuable material, the service can be offered at less than actual cost. Already thousands of clinicians the world over have received valuable educational assistance from the Library and Department of Literary Research of the American College of Surgeons.

As in every College, the work of these departments consists in securing all available knowledge in their respective fields and of imparting that knowledge to the students, that is, the Fellows. The specific purpose of the College of Surgeons, therefore, is to assemble knowledge pertaining to surgical education—the art and science of surgery, hospitals, and other activities having to do with the health of humanity—and to disseminate this knowledge through the Fellows of the College who work on this great educational campus.

Important as are the activities of the American College of Surgeons which are carried on in Chicago through the various departments of the College, they represent but a part of its educa-

tional activities. The sectional meetings and the annual Clinical Congress, together with the hospital standardization program and the programs of the various College committees, make its activities international in scope. Thus we may truly say that when a surgeon is admitted to fellowship in the American College of Surgeons and pays his life membership fee of $500, or his annual membership dues of $25, he matriculates in an educational institution which undertakes to give him the greatest possible facilities for his further advancement in the science and art of surgery. Every hospital staff meeting, every committee meeting of the College, every regional meeting, every Convocation of the College, every set of histories submitted, constitute a part of the mass effort which is being made in behalf of the Fellows of the College. In other words, the headquarters of the College in Chicago, together with all of the hospitals in Canada and the United States which have conformed to the minimum standard, constitute the campus of the American College of Surgeons. It should be emphasized, however, that as in any academic college the benefits derived by each individual depend entirely upon himself.

And now the American College of Surgeons is considering the establishment of another and most important department—the Hall of the Art and Science of Surgery. The exhibits in this Hall of the Art and Science of Surgery will present not a static but a constantly progressing panorama of contemporaneous methods of surgery and of the applications in surgery of the allied sciences upon which surgery depends. This department will be under the direction of Dr. Crowell.

TRAINING FOR SURGERY

The type of educational work that the American College of Surgeons has been fostering on a large scale is postgraduate education. The undergraduate school is primarily concerned with the theory of surgery; the American College of Surgeons is primarily concerned with the practice of surgery. The training of a surgeon cannot be effected within a stated period of time with a final examination. An examination in the theory of surgery alone could be no safe guide for judging the fitness of candidates for the practice of surgery. An examination in the theory of surgery would not indicate whether the candidate has a surgical mind, thinks clearly, is skillful, and has good judgment and common sense, and whether he has ethical and moral standards.

It would be as logical to weigh a man to see if he is honest as to examine him in theory to ascertain his skill and ethical standards. The certificate of the undergraduate teacher should attest whether or not the candidate has enough theory and it may be said that the greatest surgeons living today probably could not pass an examination in the theory of surgery. Leonardo da Vinci would not be judged by his knowledge of the theory of color, nor Beethoven by his knowledge of the science of sound.

Students are taught the theory of surgery; they are trained for the practice of surgery. The undergraduate teacher certifies to the theoretic qualifications of the student. The American College of Surgeons certifies to the practical qualifications of the candidates for fellowship and matriculates them into the College as Fellows to train them in surgery during life. Therefore it cannot be overemphasized that every one of us must be in college for the period of our lives, and that our advancement and our training should be as active in one period as in another. All that the university can do in its examinations, all that the Credentials Committees of the College can do in regard to its requirements, is to candle the egg. Undergraduate education and training for surgery have made enormous strides in this generation and now mass education for the men in practice is undergoing an equally striking development.

There are two types of personalities in regard to whose work the teacher is apt to miss judgment. One type includes the men with well developed memory mechanisms who easily acquire honors while in the university but who by the time they get their degrees and their postgraduate training lose the stimulus of their training and never have an independent growth. These minds have been educated beyond their intelligence.

The other group includes the men who annoy their teachers on account of their independent way of thinking and their independent point of view. They often are not promoted and leave their hospital service early. Their teachers, however, at some later time are surprised to find that among the more outstanding pupils are those who have been rejected but who have become the pillars of the temple. Thus there are four periods through which the surgeon passes in his complete course. The premedical course in which his progress depends upon character and training; the medical course in which progress depends upon character and training; the period of interneship in which progress depends upon character and training; and the later course in which progress depends upon character and continued training. In this later course an additional and imperative incentive is added by competition with his fellows.

It should be borne in mind that we are building not in the interest of the profession but primarily in the interest of the people at large. The automobile, the airplane and other methods of transportation—the machinery of civilized man—is so distributed on the farms and ranches and in the mines, on the highways, on railways and in the air, that everybody is on the front line so that in the case of an accident, a disease, or a surgical operation it is as necessary to have a good surgeon in the most remote place as it is to have one in San Francisco, Los Angeles, Boston, New York, or Philadelphia.

Therefore our task is to see to it that there are good surgeons all over Canada and the United States; and wherever there is a human being who requires the service of a surgeon we must have a good surgeon and a good hospital.

No good surgeon can be made such by proclamation, and no pronouncement can prevent the trained, industrious student from becoming a good surgeon. Education and morals and ethics are matters of training. This was well illustrated in our experience with the Eighteenth Amendment.

Thus the American College of Surgeons while not a postgraduate school in the ordinary sense of the word is a great educational organization whose fellowships are offered to all surgeons who have given sufficient proof of their surgical ability and ethical standards and who are ready to participate in the program of the American College of Surgeons for the elevation of the standards of surgical practice and of hospitals.

THE CREATIVE PERIOD OF THE COLLEGE

The 23 years which have passed since the foundation of the College may be considered its first or creative period. This period closes with the College as the largest and most active surgical organization in the world. It is a self-supporting College. It is free from debt. It has expended $3,727,099 in educational programs and has assets in land, buildings and endowment of more than two million dollars. It is a College, not in name only, but in fact. It presents the largest, most comprehensive postgraduate medical program offered by any educational institution. Under its own budget it has carried on its comprehensive program of hospital standardization under the leadership of Dr. MacEachern until at the present time the hospitals of the United States and Canada and of other countries beyond the confines of this continent have benefited from its educational program. Its constructive campaign which has increased in efficiency through the years has brought to millions of patients untold benefits—better diagnostic laboratories; better clinical records; better pathological service; better operating room facilities; and, of especial significance, a finer spirit of co-operation among the staff members,—as evidenced by the fact that monthly staff assemblies in approved hospitals numbered 4,000 in the single year of 1934, with an aggregate attendance of over 800,000. It has established an educational standard, emphasis being laid on operative and diagnostic clinics; follow-up studies and end-results; clinical pathology; case reports; motion pictures; scientific exhibits; and group responsibility of the staff for the care of patients.

The College has held 23 annual Clinical Congresses and 175 sectional meetings. In this period the total attendance at the annual meetings and the regional meetings has amounted to approximately 121,500. The College has made contacts with the lay public in the presentation of the aims and objects of scientific medicine to approximately 400,000 people who were in actual attendance at community health meetings, to say nothing of the millions who have been reached through the press, the radio, and the 750,000 high school pupils who have been addressed by representatives of the College.

The American College of Surgeons thus brings to a close its creative period with its romance of high adventure, of trial and error, of praise and blame, with net results as stated.

DR. FRANKLIN H. MARTIN

Dr. Franklin H. Martin gave every atom of his strength and organizing genius to the American College of Surgeons during its creative period. He made the College and the Journal the passion of his life. His name will ever represent this period, now closing.

Standing by his side, sharing the anxieties and perplexities of the problem, advising and aiding, has always been Mrs. Martin. Her unheralded rôle of itself possesses enough significance to merit acclaim. Mrs. Martin received from Dr. Martin and inherited the Journal, SURGERY, GYNECOLOGY AND OBSTETRICS. She is the sole owner of this great magazine. For many years it had been the desire of Dr. Martin that upon the death of himself and Mrs. Martin this Journal should become the property of the American College of Surgeons. Mrs. Martin fully agreed with this generous intention. Through her action this has now been assured. The Journal, SURGERY, GYNECOLOGY AND OBSTETRICS, with its assets has been trusteed, the income to go to Mrs. Martin during her lifetime and upon her death it is to become the property of the College.

So at the end of its creative period we find the American College of Surgeons enriched by the gift from the citizens and medical profession of Chicago of its handsome home at the corner of Wabash avenue and Erie street, by the gift from the family and friends of the brilliant John B. Murphy of the Murphy Memorial hall and library, and now to land and buildings is added the gift of the greatest surgical journal in the world—SURGERY, GYNECOLOGY AND OBSTETRICS.

It is for me a great honor as the official representative of the 12,000 Fellows of North and South America, Europe, Africa, Australasia, and the Orient to proclaim the qualities, and to acknowledge our everlasting obligation to our departed leader, to express to Mrs. Martin our deep appreciation not only of the gift of the Journal but of the even greater gift from Dr. Martin and herself of prophetic vision, great achievement, and faithful friendship

THE TREND OF SURGERY[1]

DONALD C. BALFOUR, M.D., F.A.C.S., Rochester, Minnesota

THE medical historian of the future probably will refer to the past fifty years as marking an era of unprecedented advance in all branches of medicine, and will hazard the prediction that it is doubtful if equal progress ever again will be made in the same period of time. Certainly in the field of surgery such a prediction seems well founded. In this era the great accomplishments of surgery have been made because anesthesia and asepsis made possible the application of knowledge of pathology, physiology, biochemistry, and roentgenology, and in turn a deliberate, scientific, and safe approach to every part of the body. Much of the extraordinary development in the knowledge of disease can be attributed to the fact that surgery provided a method by which the "pathology of the living" could be completely revealed and its effects studied. In the beginning of this era surgical exploration all too frequently revealed a condition which was obviously the terminal stage of a lesion that might have been satisfactorily dealt with in its incipiency. Surgery, therefore, can be credited with giving the impetus to clinical and laboratory methods of identifying lesions in the early stages of their evolution; in some fields, surgery made possible recognition of the conditions under which lesions may occur. Thus, surgeons of all countries have added to knowledge of disease in its various stages, and the ready availability of reports of observations made the world over has placed the present era in surgery in so distinguished a position.

Innumerable examples could be cited to illustrate the progress of surgery during this period. Major surgical procedures are now carried out with such safety that the predictions of surgeons only a few years ago are forgotten. The great surgeon Langenbeck, when Billroth was endeavoring to find a safe method of resecting the stomach for cancer, stated that he looked on the attempt as "only a quicker way of taking out of the world a patient whom it is impossible to save." Yet today this operation is routinely performed, with a resulting definite percentage of cures in cases of malignant disease and with consequent restoration of health to those who have benign lesions. Again, it is a far cry from the times of John Hunter who said, "To perform an operation is to mutilate a patient we cannot cure; it should therefore be considered as an acknowledgment of the imperfection of our art." The most significant trend of surgery has been the attempt to control, ameliorate, abort, and prevent those conditions which are known, or suspected, to be dependent on disturbed physiological processes. In the treatment of peptic ulcer, for example, the attempt to achieve by surgical measures the ideal in management of the disease—to effect permanent inhibition of a hyperactive function, particularly of the secretory mechanism—has resulted in the employment of a number of procedures to bring about such control in the simplest and most physiological way. The surgery of the sympathetic nervous system is an entirely new approach to the treatment of those diseases which are characterized chiefly by vasomotor spasm, and the future developments in this field of surgery probably will be as startling as those that have already been made. Again, the attempt to employ a similar method of approach in treatment of those conditions which may be dependent on normal or abnormal activity of the ductless glands, may open up great possibilities for the surgical treatment of a wide variety of conditions which may be attributable primarily to altered physiological function, particularly of the vasomotor system.

The factors contributing to these great advances in surgery have come from every field of medicine. As already has been pointed out, surgery, in revealing the actual disease, gave the initial impetus to a more exact knowledge of disease. But second only to surgery have been the roentgen rays. The place of roentgenology in the diagnosis of lesions in every region of the body cannot be overestimated. Not only have these rays made possible detection of lesions before any method known at present can detect them, but, with biopsy and knowledge of cellular differentiation, accuracy in prognosis has been immeasurably improved. The fact that by roentgen rays lesions can be identified before clinical manifestations are present, has been an enormous benefit to mankind in making possible early and effective treatment. The recognition of pulmonary tuberculosis, of cancer of the gastro-intestinal tract, and of lesions of the skeletal system are examples to substantiate this fact. From the clinical and experimental laboratories have come those innumerable exact tests and observations which, when employed intelligently along with careful study of the

[1]Presidential Inaugural Address presented before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

patient and the subjective and objective signs of disease, have added so much to diagnosis, prognosis, and successful therapeusis. These factors in surgical progress, therefore, have been applied in strengthening the base on which successful treatment may be founded, namely, an accurate diagnosis. It is certainly true that modern medicine has brought diagnosis more nearly to an exact science than ever before.

The medical profession of America has played a prominent rôle in initiating and participating in the advances which have brought surgery to such a high level. Haggard, in his address as retiring president last year, not only emphasized this fact but drew attention to the many important contributions from pioneer surgeons living in communities remote from medical centers, and to the superior opportunities which such environments afford. Again, in North America the development of those collateral fields of medicine which have made modern surgery what it is today, has been conspicuous. This development has come about chiefly through specialization. Whether or not medicine has become too highly specialized, it always will be true, as Herbert Spencer pointed out, that it is only through specialization that progress can take place. Specialization in establishing standards always will be necessary to determine the possibilities in any field of medicine, and for this reason specialization always will be the forerunner of improved methods of practice. The influence of those engaged in special surgical fields is seen throughout America. In the smaller hospitals, which have been such an important feature in the development of medicine on this continent, the character of the work, whether the hospitals are staffed by specialists or not, gives unmistakable evidence of familiarity with the best diagnostic and therapeutic measures, knowledge of which has been acquired through travel, intensive graduate courses, and study of the medical literature. The improvement of medical practice in the smaller communities has been such that the care of the sick in America is not excelled in any other country of the world.

The situation which confronts the recent graduate in medicine who desires to become a surgeon is a perplexing one, for even a superficial knowledge of the extent of the field of surgery will, or shall, make him uncertain as to how much of this field he can master. Whatever his choice may be, there is more and more evidence that he realizes the necessity for prolonged training to equip himself sufficiently for practice in either general surgery or in any special branch of surgery. While it is true that because of natural aptitude and continuous and conscientious study many surgeons in America have become outstanding without a graduate apprenticeship, yet the great advances which have been made in recent years in all branches of medicine have rendered it more and more difficult for anyone to acquire real competence without an adequate training; so the quality of medical service in any community is in direct ratio to the training of the professional personnel.

Just as the need for special training affects the young surgeon, so also does it bear on the whole practice of surgery. The future of surgery in America depends primarily on the adequate training of those aspiring to a career in the field. To demand, however, a protracted training while the opportunities for it are so unorganized as at present is not consistent, as recently has been inferred in an editorial in the *Journal of the American Medical Association:*

"Growing demands for training in special fields of medicine have given greater significance to the available types of graduate instruction. To present, as clearly as possible, a picture of existing opportunities for advanced study, the Council on Medical Education and Hospitals has obtained reports from all universities having faculties of medicine. Two universities have separately organized graduate schools of medicine. Twenty-nine report that they offer systematic courses of instruction for physicians. An apprenticeship type of training through residencies or fellowships is available in fifty-three institutions. Extension teaching of a less formal sort is conducted by nineteen schools, and as many more do not engage in any form of postgraduate work. Graduate teaching is a heavy tax on the resources of an institution, and not many of our schools are equipped to engage extensively in this work. This is particularly true of the intensive courses demanded by physicians who have already engaged in practice. Generally speaking, they are able to pay in cash for what they want, but because of greater earning power and social responsibilities, they cannot devote any unnecessary time to this phase of training. Younger men who have never practiced may be willing to pay for experience with time and services after the traditional manner of apprentices."

The evident need should be the incentive to make available sufficient opportunities for a fitting training in surgery.

From what has been said, it is evident that the proper classification of undergraduate and graduate teaching in surgery is the first essential. Undergraduate teaching in surgery should be restricted

to the teaching of fundamentals and general principles, while graduate teaching should carry out the training for practice in surgery through surgical residencies or fellowships. The granting of the right to practice surgery by state and national boards which require no practical evidence of competency, has been unfair both to the recipient of such a right and to the public. The American College of Surgeons was the first organization in the country to attempt to correct this evil by requiring evidence of experience and proficiency before implying it. The College indirectly has done much to keep before the attention of the profession the fact that an undergraduate course in medicine and a year's interneship do not and cannot give sufficient opportunities for training in surgery to warrant certification of competency in surgery in these days.

The question, therefore, of the training which shall be required of the surgeon becomes of immediate interest and of particular importance in America, since in respect to requirements we cannot claim to be as advanced as are some other countries. The advantages which may grow out of our freedom from long established customs in surgery may be outweighed by the evils which may follow such freedom. That the medical profession is well aware of our shortcomings in this respect is seen in the establishment of qualifying boards for many of the surgical specialities. The methods adopted and practiced by the qualifying boards already formed have so much to commend them, that it is probable that in all fields of medicine similar boards will be set up to designate those qualified to announce themselves as specialists in the various fields. The effectiveness of such qualifying boards is dependent on the approval, support, and recognition of organized medicine, and it is gratifying that such co-operation is being given.

The distribution of population in America creates another problem for investigation, namely, it should be determined in what way the education of surgeons can be adapted to the varying needs of small and large communities. A graduate training in surgery of three, four, or five years after completion of an interneship is, to a large extent, not applicable in the small community, and it seems imperative that some distinction be made in the requirements that various communities may present. The Council on Medical Education and Hospitals of the American Medical Association, and the American College of Surgeons, in respect to establishing minimal standards for medical schools and hospitals, have already done much to solve this problem in proving that the hospital which cannot, or does not, acquire these minimal standards and does not select its surgical staff on the basis of competency and character, sooner or later loses some of its standing in the community. With a better distribution of well equipped hospitals, the adequately trained young surgeon will find greater opportunities for applying his knowledge and ability. The surgical residencies which are available to the young graduate today seem to be sufficient, at least in number, to serve the need of those who settle in the relatively small community with the responsibility of dealing with those emergent surgical conditions in which the life of the patient depends on recognition of the emergency, a knowledge of what should be done, and the ability to do it. In the most recent study of the Council on Medical Education and Hospitals of the American Medical Association, there are listed 442 surgical residencies in the hospitals of the United States, and of these 73 per cent are for a period of a year. A twelve months' surgical residency following an adequate interneship should at least determine whether the resident possesses superior qualifications to justify continuing in a more extensive training, or whether the knowledge he has acquired could be applied best in the smaller communities. The investigations of medical schools, interneships, and hospitals, which have so improved medical education and practice in this country, could well be extended to include a study of the training which existing residencies offer.

The trend of surgery in America can be viewed with optimism. In every surgical field treatment is becoming more efficient, and the willingness to discard apparently well established, major surgical procedures for simpler methods has resulted in some of the most remarkable advances of modern therapeutics. The irradiation of benign and malignant tumors and other lesions has completely altered the management of some of the most serious conditions, and there seems little doubt but that the applicability and the effectiveness of irradiation will steadily increase. The injection of sclerosing substances in treatment of various conditions, and the development of transurethral surgery are notable examples of a trend of modern surgery particularly obvious in America, namely, the search for methods which will reduce morbidity and mortality to a minimum. Such advances have come from intensive effort expended by those highly skilled and widely experienced. It is in the co-ordination of these special fields and in the evaluation of various therapeutic measures that the American College of Surgeons has one of its most important functions.

In working out the problems touched on here, the American College of Surgeons should play an important part. The purposes of the College are the highest, for its every activity is designed to elevate surgery and to improve constantly the quality of surgical service made available to the people of America. In the fulfillment of these purposes a great debt of gratitude is due to the founders of the College, and to the vision, courage, and extraordinary organizing ability of its late Director General, Franklin H. Martin. It is not generally appreciated that the formation of a College of Surgeons in America twenty years ago could be undertaken only on the principles laid down by its founders. The chief of these principles concerned Fellowship in the College. To meet existing conditions, the requirements set up were characteristically American; the qualifications for Fellowship were based on proficiency and character, attested by those familiar with the candidate and his work. The added provision that a minimal period of eight years must elapse after graduation from medical school before applying for Fellowship, largely eliminated the defects of any system which would grant Fellowship on the basis of scholastic standing only, for the most profound knowledge of basic sciences and of the theory of surgery does not necessarily make a competent surgeon. Again, the College has given support and encouragement to its Fellows by the standardization of hospitals, by providing opportunities for attending clinics in medical centers, and by taking its part in the program of public education on which organized medicine has embarked. The accomplishments of the American College of Surgeons are recorded in the status attained by American surgery today, and it is to be hoped that, in any modifications of the policies of the College, the ideals on which it was founded will always be retained.

SYMPOSIUM ON CANCER

TREATMENT OF MELANOMA[1]

Report of Four Hundred Cases

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I HAVE great admiration for the committee of the American College of Surgeons that worked out the general scheme of this program. It is high time that some group seriously pondered over the problem and decided on what should be considered standard therapy in some of the major forms of cancer.

Surgeons are apt to overemphasize the surgical approach to the cancer therapy. Roentgen and radium therapists likewise overemphasize their form of therapy. In general, those who employ both methods freely are convinced that irradiation in one form or another has gradually extended its field of usefulness while the surgical lines are a little narrower and more cleanly cut. However, all now agree that definite types of cancer are preferably treated by surgery; certain types by irradiation; while other types are better treated by a combination of both surgery and irradiation. In another group, we do not yet know which is the preferred form of treatment.

My understanding is that the purpose of this symposium is to help crystallize the results of our experience in therapy and to attempt to arrive at a more definite conclusion on whether surgery, irradiation, or a combination of these should be employed in definite types of cancer. These conclusions must be based on a large experience and arrived at by judicial and careful studies of our cases.

MELANOMA

The nomenclature of the malignant pigmented tumors has always been confused. Some dermatologists apply the name melanoma to certain benign heavily pigmented lesions and call the malignant tumors of this type malignant melanoma. A generic term for the entire group is melanoblastoma which is subdivided into 2 classes—melanocarcinomas and melanosarcomas, depending on the preponderance of epithelioid or spindle cells in the tumors. We employ the word melanoma to designate all malignant tumors derived from melanin-producing cells or cells capable of producing melanin, namely, melanoblasts. The precursory lesions which may change to melanomas are called pigmented nevi.

Melanoma is one of the most malignant of all tumors. This tumor is important not only because of the attributes of extreme grades of malignancy, but also because of the fact that no single tumor in the entire realm of oncology offers the clinician more divergent opinions as to what constitutes proper procedure.

In this paper I shall discuss only the more common and practical problems which the melanotic tumor present to the practitioner. In the past 10 years many original and valuable studies have been made on the subject of melanoma, so that we today are more enlightened on its finer points in histopathology, some of which have been made possible by silver staining. We know more about the chromatophores; more of its relationship to other tumors such as the neurogenic sarcoma; more of the coincidence of intermedian output from the hypophysis; more about its clinical behavior.

Melanoma arises from a specific mesoblastic cell, the melanoblast and possibly also from epithelial cells which have been modified by the production of pigment. The melanoma may be primary in the skin, the choroid coat of the eye, the rectum, the vagina, the intestine, the meninges, the mucous membrane of the mouth and cheek, the sclera of the eye, and the nail bed. The diagnosis is chiefly confused with that of pigmented epithelial papilloma and with the pigmented neuronevus. In many instances arriving at the correct clinical diagnosis is simple, and in many instances, is almost impossible. However, the jet black, elevated, smooth, shiny melanoma cannot be easily mistaken for other lesions. It is the variants of this tumor that lead to confusion; for example, the non-pigmented melanoma is difficult to distinguish from a benign nevus.

Melanoblasts are present in great abundance in two tissues, especially the skin and the eye. In

[1]Presented in the Cancer Symposium, before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935. Aided by a grant from the Research Council of the American Medical Association.

the eye the pigmented cells of the retina as well as the pigmented mesoblastic cells of the choroid, have the function of melanin production. In the skin, the heavily pigmented areas are more frequently the sites of melanotic tumors particularly in the region of the external orifices. A site in which melanomas may occasionally occur and which is liable to be overlooked is the cleft between the toes. The nail matrix and the conjunctiva occasionally contain melanotic tumors. Primary tumors are infrequent in the viscera; the majority of reported cases when subjected to careful analysis, are evidently secondary or metastatic tumors of unknown primary origin.

As a rule this lesion is congenital. In our series most patients described it as an inherited lesion. There were some instances, however, which seem authentic because of the intelligence of the patient, where there was no lesion until a short time before the development of the melanoma.

The frequency of occurrence of nevi and melanomas is similar for the face, neck, back, and upper arm, but in other regions there is an interesting disparity. Melanomas are of frequent occurrence on the soles of the feet and on the genitalia, in which regions nevi are seldom observed. Nevi are more frequent on the upper extremity than on the lower extremity, whereas melanomas are more frequent on the lower extremity than on the upper extremity. These findings are in agreement with our observations that certain melanomas of the feet and genitals originate on skin which is apparently free of pigmented moles.

In our cases 20 per cent of the melanomas were situated on the head and neck, 16 per cent on the feet, 18.7 per cent on the trunk, 8.7 per cent on the leg, 10.9 per cent in the eye, 6.5 per cent on the arm, 1.3 per cent on the skin of the breast, 1 per cent on the male genitals, 3 per cent on the female genitals, 1.3 per cent within the oral cavity, and 2 per cent were of undetermined origin.

The frequency of pigmented moles is generally underestimated. In a careful survey of over 300 people, Pack has found that the average person has at least 20 pigmented moles. Last winter I heard the chairman of an important cancer committee state before a large lay audience that one should have every mole on the body removed. It is obvious that he was not very familiar with the common problems which present themselves to the clinician. As the average person has about 20 pigmented moles, if he has reached the age of 40, there must be some common sense rule developed to guide us. Such a rule would be the following: *Leave the brown moles alone, be concerned only with those which definitely contain black pigment.*

In many instances melanoma, although present in a particular site, may lie dormant for many years. However, under certain extraneous influences it is not unusual for the tumor to commence growth and dissemination. These factors which start the lawlessness of the growth are such episodes as a scratch or laceration of the tumor, an infection, or crushing injury. Even such factors as the multiple insults delivered by a wash cloth, the rubbing of a foot lesion by the shoe, the pinching of the collar band or belt, may be sufficient to precipitate the growth factor in a melanotic tumor which has previously been dormant.

A child may have a congenital nevus which may grow only in proportion to the growth of the body as a whole. The child may grow up and go through its entire life without the tumor taking on characteristics of lawless growth, even though it may be very cellular microscopically. I have been much interested during the past 5 years in excising a number of melanomas for study, the removals being done during the course of other operations. In the beginning I was greatly astonished to find many of them microscopically malignant. Many quiescent melanomas are therefore malignant; but the one phase of lawless growth, the explosion, has not yet taken place.

This thought brings us to the question of what should be done in the case of the congenital quiescent melanoma, and on this point one finds a wide divergence of opinion. These opinions fall into 3 main groups: the first group are those who feel that it is best to let a sleeping dog lie; these believe it is safer to gamble on the future of the tumor becoming a gangster rather than to disturb it. They are willing to take a chance on future scratches, rubbings, injuries, etc.

The second group is composed of men some of whom are dermatologists. They attack the black mole with the electric needle. For this type of therapy I have less than meagre regard. In fact, I am convinced by the study of our 400 cases that the electric needle applied with good intent but without sufficient accuracy, is the one trauma responsible for as much wild growth as any other form of injury. It is depressing to realize how frequently our patients give a history of having been perfectly well until the day he went for advice concerning his black mole, at which time electrodesiccation of the tumor was carried out. My objection to this technique is that it is impossible to know exactly when all the cells comprising the tumor are coagulated, and that too frequently a portion of the tumor is left unco-

agulated. Recurrence and mutation thus takes place as a malignant tumor from a tumor previously quiescent.

To the third group I claim allegiance. We believe that the best way to treat a quiescent melanoma is by simple, careful, scalpel excision, being cautious in going wide of the tumor in every direction, even going down to the fascia in most instances. One should exercise caution during the operation not to touch the actual tumor with forceps or knife. This treatment is good prophylactic cancer surgery and I have not witnessed any recurrences of the quiescent melanomas when this procedure is carried out.

Once having gotten under way in its full activity as a malignant tumor, melanoma takes one or more of three courses: First, it may grow locally, invading the surrounding skin and subcutaneous tissues. Second, it may be disseminated to distant parts, being carried by the blood stream to the liver, lungs, brain, spine, etc. In this type of metastasis, usually no known therapy is of much avail. Third, metastasis may take place by way of the lymphatic channels to the nearest regional nodes, and it is in this type of extension that most of our cures come.

TREATMENT

There is no tumor which places the clinician in such a mental state of helplessness as the melanoma once it has left the original site.

The types of therapy in most general use are irradiation and surgery.

1. Irradiation. A considerable number of our 400 cases were treated by irradiation alone. This therapy was used in those instances in which the disease was far advanced, merely as a palliative measure. It was frequently employed about the face in positions in which a proper surgical operation would have been very mutilating. Only rarely, however, was there a case in which the tumor completely disappeared. Melanoma occasionally responds like any other radiosensitive tumor. Nine patients survived the 5 year period who were treated by irradiation as the complete therapy, but of these 9 cases 3 patients are dead, 3 have disease present, and 3 are free of disease.

Our study of the results of irradiation therapy is very disappointing. In those advanced cases in which palliation was most desired, irradiation failed. In fact it nearly always eventually failed. We found that in only 2.5 per cent of our cases was there evidence of irradiation response. In other words, a melanoma is much more radioresistant than most other tumors. Irradiation is, therefore, at the present time not to be considered proper treatment. We are disappointed to arrive at this conclusion because surgery very much needs a strong ally in this field. We do not stand alone in this viewpoint. Even such an aggressive protagonist for irradiation therapy as Ewing believes that, at the present time, irradiation offers very little for the treatment of melanoma.

2. Surgery. In the absence of encouraging results from irradiation, we are left with surgery as our nearest approach to a method of combating this disease. The 400 cases covered by this report were admitted to the Memorial Hospital during the 18 years between 1917 and 1935. One hundred and fifty-five cases, or 39 per cent, were primary, and 245 cases, or 61 per cent, were recurrent.

a. Primary. Of the 155 primary cases, 50 were "primary advanced" cases in which no cure was to be anticipated. And in the 105 primary operable cases, it was deemed that there was an opportunity for cure. This means that of the total 400 cases studied only 26 per cent, or 1 in 4 cases, has a fighting chance of cure.

In considering 5 year results, it must be stated that of these 105 primary cases, 70 patients were admitted prior to January 1, 1931. We, therefore, have 70 primary operable cases on which can be reported the 5 year results of treatment. Of these 70 cases, 23, or 33 per cent, survived the 5 year period (Table I).

In these cases treatment consisted in surgery alone, and in some a combination of surgery and irradiation, reliance, however, being chiefly on the surgical procedure.

TABLE I.—38 CASES OF 5 YEAR SURVIVALS

	Primary	Recurrent
Total cases	23	15
Free of disease	18	5
Alive with disease	2	1
Lost	1	2
Dead	2	8

b. Recurrent. Of the 245 recurrent cases, 141 were far advanced, and 104 cases, although recurrent, seemed to offer some opportunity of cure. Prior to 1931, 100 cases were classified as advanced and 55 as recurrent operable. Of the total 151 recurrent cases up to 1931, 15, or 10 per cent, survived the 5 year period; 8 of these, however, later died of disease (Table I).

Of the 55 recurrent operable cases prior to 1931, 15 patients, or 27 per cent, survived the 5 year period, and this figure, 27 per cent, compares favorably with the 33 per cent 5 year survivals of the primary operable group; however, not as large a proportion of these recurrent cases re-

mained cured. If one includes every case prior to 1931, no matter what group it falls in, there are 267 cases, and of these, there are 38, or 14.5 per cent, 5 year survivals.

3. *Coley's toxins.* In 15 cases here reported, Coley's toxins were used usually along with irradiation or surgery or both, but as no one patient of these 15 cases survived a 5 year period, it must be considered that it was used as a measure of desperation and obviously added nothing to effective therapy of melanomas.

TABLE II.—267 CASES TREATED PRIOR TO 1931

	Number	Per cent
Dead	165	62
Cured	33	12
Living with disease over 5 years	5	2
Lost	64	24

It is appalling that in 38 instances, or nearly 10 per cent, electrodesiccation of the lesion was employed.

In 26 cases the disease was primary in the eye. Melanoma of the eye has a rather typical course; it survives for many years after the eye's enucleation, before manifesting itself in other locations. It then usually appears at the liver. In one instance there was a period of 25 years between the enucleation and the clinical signs of metastasis to the liver.

Subungual and intra-ocular melanomas are probably the types in which best results are obtained by treatment. On the other hand melanoma of the vulva, the intra-oral cavity, and the rectum are especially fatal.

TRAUMA, A CAUSE

Melanoma is one of the rare forms of cancer in which there is a causal relationship between injury and the activation of a malignant process. It is not to be inferred, however, that injury is the only cause of this activation. The injuries reported were many and varied in type. In one instance a hypodermic injection of typhoid vaccine was given through a quiescent mole, which immediately commenced its wild growth. Numerous instances are given of the patient cutting a mole on his face while shaving.

A factor of greatest importance is the duration of time which elapsed between the beginning of lawless growth and the treatment of the patient. This averaged 2 years and 2 months. Possibly such delay may be accounted for by the fact that the patient thought the lesion had been present for years, and therefore was still unimportant.

SUMMARY

1. Melanoma is one of the most malignant of all malignant tumors.

2. A fair proportion of 5 year cures can be obtained in early cases *if* a well planned operation is performed, and to do this the operator *must* go wide and deep. The tendency is to excise too close to the lesion.

3. The 5 year results of operation are 33 per cent for the primary operable and 27 per cent for the recurred operable melanoma. However, the great majority of cases that present themselves are advanced, so that no therapy will produce a cure.

4. The non-pigmented melanomas are commonly not diagnosed before operation. They are usually, therefore, badly handled. They have a high degree of malignancy, being usually grade 3. They are, however, commonly radiosensitive.

5. Thirty-eight cases of 5 year survivals of melanoma are reported.

6. Our best results in treatment take place when the melanoma is situated in the eye or beneath the nail, and our worst results are associated with disease in the vulva, the rectum, and within the mouth.

7. Irradiation and Coley's toxins are of questionable value. The only method of therapy to be employed is aggressive, exact, well planned and skillfully executed surgery.

8. If we are ever to improve our results in the treatment of melanoma, it must come along the line of applying a common sense rule as to which moles to leave alone and which to remove. In the removal of the mole containing black pigment as a prophylactic measure lies our chief hope of improving the percentage of patients cured. More and earlier surgery should be employed, rather than less.

THE TREATMENT OF PROSTATIC CARCINOMA[1]

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THE control of prostatic carcinoma presents one of the most difficult problems in the field of cancer. Many urologists believe seriously that its control is impossible. While we acknowledge the difficulties, we believe that in a small number of cases they can be overcome.

Intelligent treatment of prostatic carcinoma presupposes an accurate conception of the pathological anatomy of the carcinoma with particular emphasis on the point of origin. Considerable confusion has arisen as to the exact lobe or lobes in which the cancer originates.

The examination of very small prostatic cancers found at autopsy, clinically undiagnosed and undiagnosable, indicates that, in about 75 per cent of all cases, the posterior lobe of the prostate is the place of origin of prostatic cancer. In 2 such cases, Young first reported small prostatic cancers originating in the posterior lobe; Moore, in 52 autopsy cases, reports 75 per cent having origin in this lobe. In the 25 per cent remaining of all cases, the origin of the cancer may be in the lateral, median, or anterior lobes. There may be multiple foci of origin.

When the prostatic cancer has become sufficiently large to be clinically diagnosed, in most cases it has extended beyond the posterior lobe into the lateral or median lobes and into the sheath of the prostate. In 27 prostatic cancers small enough for radical resection, Young found but 1 case in which the posterior lobe alone was cancerous. Randall, examining still more advanced prostatic cancers, dissented from the posterior lobe origin. There is considerable proof that the cancer may remain for a long time in the posterior lobe, that it may extend beyond the posterior lobe, the perivesical lymphatics, and the retroperitoneal glands without involving the median or lateral lobes. Reports are found in the literature of cases in which the median and lateral have been removed and showed no cancer but the patient finally succumbed from cancer originating in the posterior lobe.

ASPIRATION BIOPSY

The control of prostatic cancer depends upon the diagnosis of the carcinoma in its early stage. Aspiration biopsy through the perineum has been a great help in the diagnosis of such cases. One succeeds in obtaining prostatic tissue in about 80 per cent of the cases which are aspirated. The pathological diagnosis of this aspirated specimen depends upon special training on the part of the pathologist. Tissue may be aspirated easily from the posterior lobe, but it is more difficult to obtain from the median and lateral lobes.

ANATOMY OF THE PROSTATE

A study of the anatomy of the normal prostate shows it to have the shape of a somewhat flattened cone with its base at the bladder end and its apex downward along the urethra. The entire prostate is below the bladder, and this posterior lobe, which is the source of origin in so many cases, begins one-half inch below the bladder neck, a position which makes difficult the proper irradiation of the lobe by the implantation of radon seeds through the bladder opened suprapubicly.

OPERATIVE CONTROL

Progress in the operative control of prostatic carcinoma has been slow. A study of the cross section of the prostate reveals how small the field of operation is. Operative removal presupposes much trauma to the cancerous tissue. Trauma, following Ewing's dictum, is the greatest factor in dissemination of the cancer. One of the earliest changes in prostatic carcinoma is "perineal invasion of the prostatic capsule" (Moore). Invasion of the vesicles and distant lymphatic invasion, however, is a late manifestation. This fact might be construed as favoring either operative removal or irradiation treatment. Young, who originated radical resection, reports the cases of a few patients operated upon and very few 5 year cures. No other urologist shows even comparable results.

TREATMENT BY IRRADIATION

Irradiation offers the only hope to control these difficult cases, and irradiation means the combination of deep X-ray therapy and intraprostatic irradiation. We have sufficient proof that neither of these alone is enough to control the disease. Deep X-ray therapy and intraprostatic irradiation should be administered simultaneously as far as possible. Our present conception of the proper way to apply deep X-ray therapy (200 kilovolts) is that it should be given through 5 portals of entry; 300 r being given daily at a distance of 70 centimeters until 1550 to 1900 r or even more are given to each portal.

[1] Presented in the Cancer Symposium, before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

TABLE I.—PROSTATIC CANCER CASES CONTROLLED

	Total cases	Cases	Per cent
First series	46		
Radiation of prostate alone—no external irradiation—well 5 years		5	10
Second series	351		
Too extensive for treatment			20
Irradiation of prostate alone—no external irradiation—controlled 3 years		29	8.3
Controlled over 5 years		20	5.7

TABLE II.—SIZE IN 322 NON-CONTROLLED CASES

	Cases
Extensive	294
Medium	19
Small	9
Total	322

TABLE III.—SIZE IN 29 CONTROLLED CASES

	Cases
Extensive	15
Medium	7
Small	7
	29

TABLE IV.—TIME FROM WHEN FIRST SEEN TO DEATH IN 322 NON-CONTROLLED CASES

	Cases
1 to 6 months	91
6 to 12 months	72
12 to 24 months	80
2 to 3 years	32
3 to 4 years	12
4 to 5 years	3
5 years	3
? years	29
Total	322

TABLE V.—TIME WELL IN 29 CONTROLLED CASES

	Cases
3 to 5 years	9
5 to 10 years	16
More than 10 years	4
Total	29

TABLE VI.—DIAGNOSIS IN 29 CONTROLLED CASES

No pathological diagnosis	14
Pathological diagnosis	15

1. Carcinoma (aspiration)
2. Adenocarcinoma
3. Adenocarcinoma grade 1 radioresistant.
4. Carcinoma probable not positive (aspiration)
5. Adenocarcinoma—some infiltration grade 2
6. Papillary carcinoma of bladder—secondary to prostatic carcinoma
7. Adenocarcinoma grade 2 radioresistant.
8. Carcinoma (diagnosis from previously removed prostatic tissue)
9. Infiltrating carcinoma grade 3
10. Probably small cellular carcinoma (aspiration)
11. Carcinoma (diagnosis from previously removed prostatic tissue)
12. Carcinoma (diagnosis from previously removed prostatic tissue)
13. Carcinoma (diagnosis from previously removed prostatic tissue). At Memorial (Ewing) prostatitis beginning precancerous changes
14. Carcinoma (diagnosis from previously removed prostatic tissue)
15. Adenocarcinoma (diagnosis from previously removed prostatic tissue)

The usual portal is 10 by 12 centimeters. External irradiation as a rule is not repeated. Intraprostatic irradiation is carried out by means of radium. If the posterior lobe alone is involved, removable radium needles, gold screened, are inserted into the prostate through the perineum; 1500 to 1800 millicurie hours are given intraprostatically every 2 months until the carcinoma of the prostate and of the periprostatic region is controlled. If the lateral and median lobes are involved, suprapubic implantation of radon seeds is the treatment of election. The seeds, having a dosage of 1.5 millicuries, are implanted throughout each cubic centimeter of prostatic tissue. One may not be able to implant the posterior lobe from this approach, in which case, perineal needles are inserted, as just described.

The treatment of retention is by means of transurethral or suprapubic partial prostatectomy with the high frequency loop. This operation is followed by irradiation in accordance with the technique outlined. Modifications of the operation and the irradiation dosage must of necessity depend upon the conditions found in the patient treated.

A study of 351 consecutive cases of prostatic carcinoma gives an idea of what even inadequate irradiation of the prostate alone can accomplish (Table I). The series in which adequate external and intraprostatic irradiation has been used, is not yet ready to report.

It is interesting that more than one-half of the cases controlled were classified as extensive (Table III); that is, the growth extended beyond the prostatic sheath and involved the bladder base or the perivesical lymphatics.

Table IV shows that the large majority of patients who are to die, succumb in the first 2

years. It is interesting that 3 patients lived more than 5 years.

Table V shows that 29, about 8.3 per cent, were well for 3 years and 20, 5.7 per cent, for 5 years. A patient in whom the carcinoma is considered as controlled must have no signs of carcinoma in the prostate, by palpation, by cystoscopy, or by aspiration biopsy. This is also true of the skeletal and other parts of the body which might be affected by the carcinoma.

The fact that the X-ray revealed metastases in 156 cases and that of these 44, or 28 per cent, showed metastases to bone, indicates how serious is the problem of control.

Table VI shows the importance which aspiration biopsy plays in the diagnosis. In 3 cases the diagnosis was confirmed by this method.

I have touched not at all in this paper upon the treatment of incurable neoplasms, particularly those with metastases to bones and around nerves. That is a problem in itself. The statistics I have quoted might well lead to pessimism in the outlook for cancer of the prostate. I believe, however, that with pains, intelligence, and often infinite patience in treating these patients, we can optimistically predict that future statistics will show at least 100 per cent improvement in our figures.

TREATMENT OF CANCER OF THE UTERINE BODY[1]

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IN estimating the comparative effectiveness of radiation and of surgical attack, radiosensitivity of the growth in question is obviously of primary importance. There has by now accumulated sufficient experience to justify classification of many of the important types of cancer with regard to degree of radiosensitivity. Stewart has published an extensive review of the literature on this subject with comment based on experience at the Memorial Hospital. Corpus carcinoma appears to be but slightly radiosensitive with the exception of a small group (12 per cent) of highly anaplastic, very malignant growths (grade 4 type).

Nevertheless, as Stewart points out, radiosensitivity may be quite different from radiocurability. The effectiveness of radiation therapy depends, as well, on other factors than radiosensitivity, not the least important of which is accessibility of the growth to concentrated, very large doses of radiation. If it is possible to utilize the caustic effects of radiation, even low radiosensitivity may not prevent destruction of the growth. This accessibility is true of endometrial growths confined in and protected by a thick walled uterus. Therefore, even theoretically it is quite possible that fundus carcinomas, though relatively radioresistant, may nevertheless be radiocurable. It is necessary to seek the answer in clinical experience.

Three years ago the Cancer Commission of the California Medical Association undertook the standardization of cancer therapy in so far as it was considered possible so to do. This was carried out by the method of consultation of physicians experienced in all fields of treatment concerned. Committees were formed to survey each type and location of cancer; committees constituted of surgeons, specialists, radiologists, pathologists, internists, numbered over 300 members. Before the final report of each committee was accepted by the Cancer Commission it was submitted to all members of all committees. This has been, we believe, the first attempt to collect and set forth the experience and opinion of the entire profession rather than of individuals or of individual groups or even of the men engaged in any one branch of therapy. It resulted in a highly illuminating and significant volume of data covering practically the entire field of malignant disease therapy.

The Committee on Gynecological Tumors, of which Dr. E. N. Ewer was chairman, made this statement in its final report, approved by the Commission: "In adenocarcinoma of the body, there is a feeling that panhysterectomy is sufficient without dissection of the parametria and that if there is any parametrial infiltration, the case should be handled with radium and deep X-ray. Surgery has been so successful in this class of corpus cancer that the committee is slow to advise any change to radium and X-ray; but it must be admitted that these agents are also very reliable and can be used with much confidence when surgery is contra-indicated. All cases for which surgery is selected should receive, if

[1] Presented in the Cancer Symposium, before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

possible, full radium and X-ray radiation 6 weeks before operation."

A substantially similar statement is contained in the report of the Radiology Committee.

Briefly, then, the Cancer Commission recommends hysterectomy with pre-operative radiation in cancer limited to the uterus, and radiation therapy in cancer extending beyond the wall of the organ.

Turning to the literature of 1933 and 1934 (since publication of the Cancer Commission reports), Zweifel collected a group of statistics from other authors and found the average reported percentage of 5 year cures after surgery appreciably higher than after radiation therapy alone, but found the highest percentage of cures when both radiation and hysterectomy had been employed. Of 19 authors reporting during this period, 10 employ hysterectomy and 9 depend on radiation therapy. Of those who do hysterectomy, the majority state definitely that their cases are selected either on a basis of histological grading, of clinical invasion outside the uterus, or of high operative risk. In cases not regarded as favorable for operation, radiation is used exclusively. This is substantially the position of the Cancer Commission, outlined above, and there appears, therefore, no good reason yet to abandon it.

In making recommendations before an organization such as the American College of Surgeons, whose members work, for the most part, in general hospitals throughout the country, the factor of availability of equipment and personnel is a very important one. The retiring president of the College, himself one of the foremost students of cancer in America, has pointed this out in a recent address (6) from which I take the liberty of quoting:

> Radiotherapy has developed to the stage where it is the method of choice for the treatment of common and important forms of metastasizing cancer, such as cancer of the cervix, even in its early stages. But, while this development of radiotherapeutics, as practiced in the great cancer institutes and hospitals, is continuing day by day, the equipment for providing radiation in adequate amount and the personnel trained to its effective use cannot be so readily or so promptly made available. Cancer institutes and special cancer hospitals are unable to supply treatment for more than a very small fraction of the 300,000 cancer patients living in this country in any one year.
>
> Under these circumstances, the majority of patients who have cancer will be obliged to seek treatment as they have in the past, in general hospitals, and at the hands of surgeons and radiotherapists who are not attached to the great cancer institutes and are not equipped with the most efficient apparatus or trained in the advanced technique of radiation therapy.
>
> We are forced to consider the different standards of diagnosis and treatment of cancer which are obtainable in different localities and to make the best possible use of the resources which are available for this purpose. Such a plan involves consideration of the indications for the selection of radium and X-ray treatment or of surgical measures in the treatment of individual cases, in so far as this choice may be restricted by the fact that one or another of these methods of treatment and the personnel qualified to administer such treatment may be available or be lacking in the locality under consideration.

It cannot be too strongly emphasized that successful radiation therapy for cancer requires a very high degree of technical skill and training, as well as the exercise of judgment and even of courage, comparable with these qualities as we have come to expect them in the competent surgeon. Even the dosage required for modern successful radiation therapy is such as to be approached with trepidation by the man whose experience and standing in this special field will not withstand criticism for unfavorable by-effects. Percentages of cures reported in the literature from large cancer services by no means present a picture of the results obtained generally by less experienced therapists. For example, the newly formed cancer committee of one of our large hospitals undertook to ascertain end results in some 50 cases of cancer of the cervix treated in that hospital up to 5 years previously and found not a single one living.

It is probably safe to state that more communities have surgeons competent to do a good hysterectomy than have radiologists and equipment adequate for the effective radiation treatment of fundus cancer.

CONCLUSION

While there is good authority for the use of radiation therapy exclusively for fundus cancer, it appears that the weight of clinical experience favors hysterectomy, preferably with pre-operative radiation, at least for cancer still confined to the body of the uterus. Especially is this true in the absence of available radiation therapy comparable to that of the large cancer clinics. For the small group of extremely anaplastic and highly malignant cancers and for cancers which have already extended beyond the wall of the uterus, radiation therapy is in any case the method of choice.

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THE TREATMENT OF CANCER OF THE COLON[1]

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THE attack against cancer has been wrought up to such a pitch that the army is prone to attack the foe before the best time is at hand —and there is, after all, an optimum time. This is particularly true in cancer of the colon and rectum. Operative intervention in the presence of cancer of the colon is practically never an emergency procedure; the only exception being in the occasional acute obstruction superimposed on the napkin-ring type of malignancy in the sigmoid. However, operations for malignancy upon the gastro-intestinal tract carry a very high mortality unless the diagnosis is accurate, the patient properly prepared, and the operative procedure properly planned beforehand.

Malignancies of the right side of the colon are rarely obstructive in nature, due to the liquid nature of the contents, large lumen of the bowel, and flat growths; therefore, as much time as is necessary should be taken to rehabilitate the patient with such measures as high caloric diet, iron, glucose and saline infusions and transfusions. In growths of the right side, the associated presence of anemia is not as bad a prognostic sign as is malignancy of the stomach or of the sigmoid, because these generally signify metastatic growths. Anemia on the right side of the colon, however, is generally due to physiological disturbances. Excision of the growth with anastomosis on the right side of the colon is a dangerous procedure because of the blood supply, and it will result in few cures, due to poor removal of the lymphatic glands. In all growths of the right side, it is necessary as well as simpler to remove the entire ascending colon including the hepatic flexure, and to do an anastomosis between the ileum and the transverse colon either in one or two stages, depending upon the general condition of the patient and the experience of the surgeon. If operation is performed in two stages, I believe that the end-to-side anastomosis, as Rankin has so ably demonstrated, should be carried out in order completely to divert the contents of the small intestine, because if the side-to-side anastomosis is made, considerable contents will still pass over the growth. If, however, the one stage operation is performed, side-to-side anastomosis may be made.

When the growth is situated in the transverse colon, I prefer to do a cecostomy, and 2 or 3 weeks later resect the growth and do an end-to-end anastomosis. Here, again, the Rankin clamp is useful, care being taken, of course, to pay attention to the blood supply. In certain cases, one could readily perform the obstructive resection type of operation as devised by Rankin if he so chooses, but many of these necessitate secondary closure. This same procedure is applicable to growths in the descending colon and sigmoid, although if the growth is in the lower end of the sigmoid, a sigmoidostomy above the growth will prove more efficacious for decompression of the bowel than will cecostomy. This is true because many of these patients have been constipated for many weeks or months and considerable fecal material has accumulated in the transverse and descending colon which would be difficult to remove by cecostomy. Resection of the sigmoid is a very dangerous procedure without some type of decompression and probably should seldom be carried out in a one stage operation, unless the lesion is very small and unless there is no obstruction above the growth or dilatation of the bowel below the growth. The Mikulicz procedure, in my experience, has been of little usefulness because it can be utilized in such a small percentage of cases.

Operations upon the colon have been fairly well standardized, but there has been great controversy regarding the most satisfactory operative procedure for malignancy of the rectosigmoid and the rectum. Many different types of operations have been devised, chiefly because of the desire to retain in some way the sphincteric apparatus, but in the final analysis of these various procedures, it is quite apparent that the disease being treated has often been lost sight of in the effort to maintain sphincteric control. Many ingenious operations have been designed to restore the lumen and this may be done perfectly well technically, but the possible curability is lost sight of due to the fact that it is the generally accepted belief that cancer of the rectum remains localized for such a long time. When one looks over the reports of the number of patients cured, this does not necessarily follow. Cancer of the breast may oftentimes remain *in situ* for 2 or 3 years but nevertheless, its dangers are not minimized.

I feel that a great error has been made in performing small operations for small cancers and big operations for big cancers. From our conception of the disease and judging by the frequent number of recurrences, perhaps the opposite procedure should be carried out. After a very large

[1]Presented in the Cancer Symposium, before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

experience with carcinomas of the rectum and a study of the locations of recurrences, Miles has given us the most lucid description of the lymphatic distribution, which is the chief mode of spread in cancer of the rectum or rectosigmoid. He concludes from this study that the most radical operation is the procedure of choice. Objections to this have always been brought up due to the occasional patient who is cured by a limited procedure, but, if this plan were followed in all cases, a very low percentage of cures would result. Therefore, we have particularly favored the one stage combined abdominoperineal operation as that which gives the most hope for eventual cure.

I think that perhaps too much attention has been paid to operative mortality when a decision is made regarding which type of operation is to be used. The advantages of a 12 per cent mortality over a 15 per cent mortality in any procedure may oftentimes be misleading, unless we know the types of cases which are operated upon and the surgeon's ability to carry out the procedure. Operability varies greatly with the experience and courage of the surgeon, but certain it is that an abdominoperineal operation, whether done in one or two stages increases the ratio of operability. We have favored the one stage abdominoperineal operation for many reasons. In the first place, we are operating upon the patient once instead of twice, and when one considers accidents beyond our control, the mortality of the combined first and second stages is higher than is apparent, because the mortality from this operation is not quoted unless the patient goes through the second stage. If he dies in the first stage, death is automatically counted as due to colostomy and not to cancer of the rectum. In the second place, the operation is more easily performed without the presence of adhesions from the previous operation and it can be performed more expeditiously and with less shock. Third, the period of hospitalization is considerably lessened. My own experience has been that, if a growth is inoperable at the first operation, it is generally inoperable at the second operation.

In the patients who come in without an acute obstruction, we feel that we can decompress the bowel in practically all cases, if a proper regimen is instituted and sufficient time is allowed. This usually consumes about a week. We use 1 ounce of magnesium sulphate to 8 ounces of water and have the patient take this over a 4 hour period each morning for many days. Cleansing enemas are also given every day and a few doses of pitressin are administered. During the hospital stay, the kidney function is estimated and if there are any symptoms of disease of the bladder, cystoscopy is done to estimate the size of the prostate or any invasion of the bladder wall by malignancy. Many of these patients are between 55 and 65 years of age and frequently have an associated prostatic hypertrophy which may be troublesome in the postoperative convalescence if it is not recognized. Blood counts are checked and transfusion is resorted to whenever indicated. The patient is given a high caloric, non-residue diet which includes candy, glucose, orange juice, etc. On the day before operation, all laxatives are discontinued, and proctoscopic examination is made to be certain that the rectum and the sigmoid are clean.

In our hands, spinal anesthesia has proved to be the one of choice because it provides excellent relaxation and a quiet abdomen. The patient is placed in extreme Trendelenburg position so that the pelvis is entirely free from the intestines. This requires a minimum of trauma in packing off the intestines. First the liver is explored for metastases, then the gland-bearing area, and finally the growth itself, the latter being done very carefully. Palpable glands do not preclude operation and neither does a moderate amount of fixation.

The first step in the operation is to mobilize the sigmoid in cases in which it is necessary, due to peritoneal folds on the lateral side. Then, we isolate the inferior mesenteric artery and ligate it just below the first sigmoid branch. This is readily detected by the use of a Cameron light in case of a thin mesentery, and, in case of a thick mesentery, it is located by incising the peritoneum of the mesosigmoid 2 inches below the bifurcation of the aorta and back close to the promontory of the sacrum. This eliminates practically all bleeding.

The peritoneum on either side of the mesosigmoid is then incised down to the bottom of the pelvis, and these membranes are joined on the anterior wall in the rectovesical pelvis in the male, or in the pouch of Douglas in the female. The hand is then placed at the promontory of the sacrum, and all the fat in the mesosigmoid in the hollow of the sacrum is pushed forward, and the dissection is carried down until the coccyx is felt. Then the rectum is dissected free anteriorly, the seminal vesicles being pushed forward until the upper border of the prostate is felt. Traction on the bowel will then bring into view the lateral attachments of the rectum which are cut. This may be done posteriorly, but if done anteriorly, it greatly facilitates the perineal part of the operation. The peritoneum is then dissected from

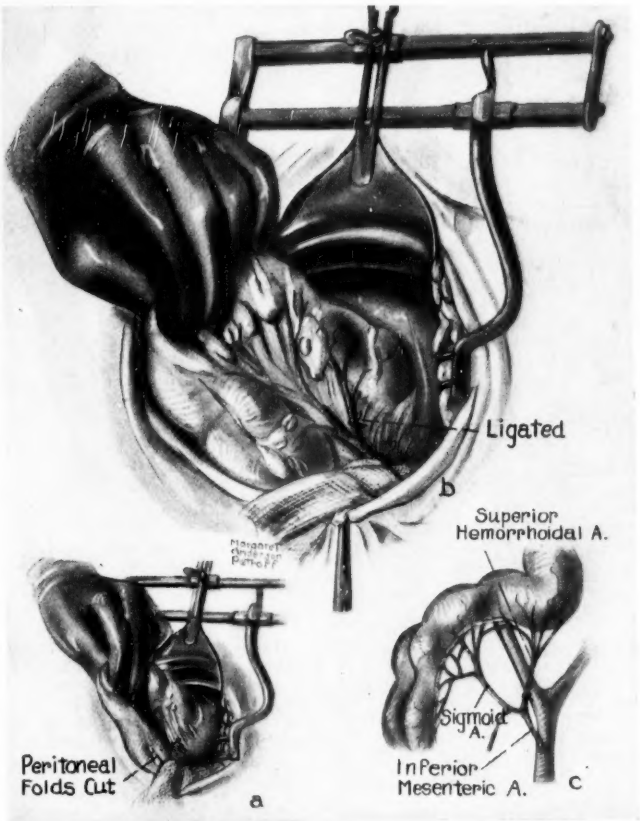

Fig. 1. a, Mobilization of sigmoid, if necessary by division of peritoneal attachments which may be present on lateral side. b, Inferior mesenteric artery identified and ligated below first sigmoid branch. c, Blood supply of rectosigmoid.

the lateral walls of the posterosuperior surface of the bladder in order to reconstruct the pelvic floor. The bowel is then divided as the last step in the procedure because, should contamination occur accidentally, it will not be of any consequence inasmuch as all the dissection has been completed.

The bowel is then divided with cautery between two Payr clamps and each end is tied firmly with a heavy silk ligature. Over each end is placed a square piece of rubber dam which is again tied over the bowel. This is very much quicker and much less apt to cause infection than inversion of the stump with a ligature. The distal end is pushed down into the pelvis. The pelvic floor is reconstructed with the flaps of peritoneum; under no circumstances should it be under tension. After all available peritoneum has been used, if there still remains a hiatus, it should be covered over with an omental graft. In the female, the uterus is used in the reconstruction of the pelvic floor. The proximal end of the bowel, if long enough, is brought out in the midline at the site of the abdominal incision as a permanent colostomy. If the sigmoid loop is short, it is brought out through a left McBurney's incision. It is my observation that people with midline colostomies are better satisfied than those with left inguinal colostomies because when they are dressed, the abdomen looks symmetrical. If a colostomy bag is worn, it fits better than a left inguinal colostomy which frequently rides the crest of the ilium, is

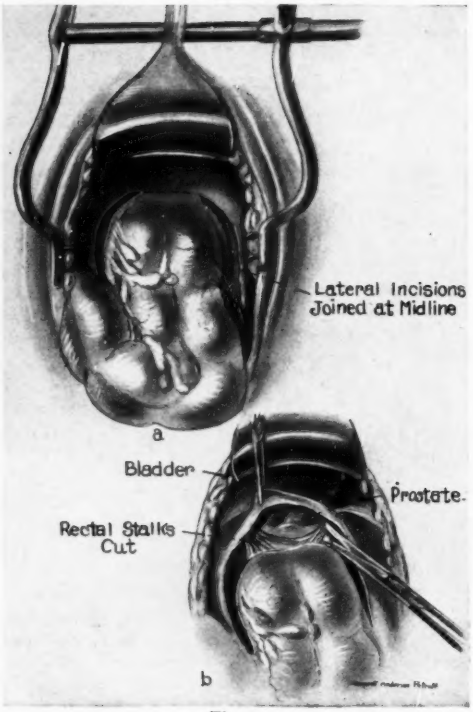

Fig. 2.

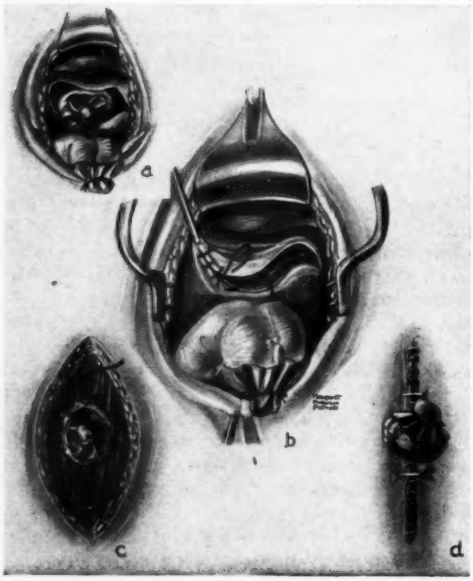

Fig. 4.

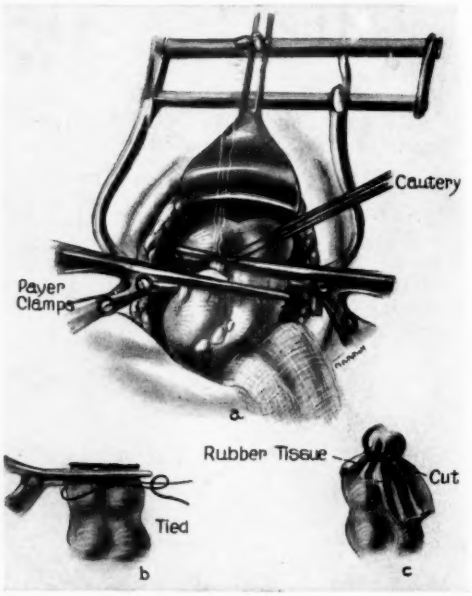

Fig. 3.

Fig. 2. a, Incisions in peritoneum on both sides of mesosigmoid until they meet anteriorly in the rectovesical pouch in the male, or in the pouch of Douglas in the female. b, Bladder and seminal vesicles pushed forward to point where prostate can be felt—traction on bowel then renders prominent the rectal stalks which are cut.

Fig. 3. a, Bowel divided between clamps and cut with cautery. b, Ends of bowel tied. c, Ends of bowel covered with rubber dam and tied again.

Fig. 4. a, Distal end of bowel pushed down into pelvis. b, Closure of peritoneum (floor of pelvis). c, Closure of muscle layer. d, Abdomen closed—proximal end of colon brought out for permanent colostomy.

decidedly uncomfortable, and, frequently, leakage occurs. The colostomy is not stitched to the peritoneal fascia or skin because with peristalsis, the stitches will pull out and thus cause a weak spot in the bowel wall through which the mucosa will blow out and cause peritonitis or severe infection in the abdominal wall. There frequently are enough appendices epliploicæ left on the bowel to rest comfortably on the fascia or the skin, which, if snugly sewed around the bowel, will prevent its slipping back. In not a single case in our series has a suture been used and in no case has it slipped.

The patient is then turned on the abdomen and placed in the Kraske position. A pursestring suture is placed around the anus, and a midline incision is made from the lower end of the sacrum

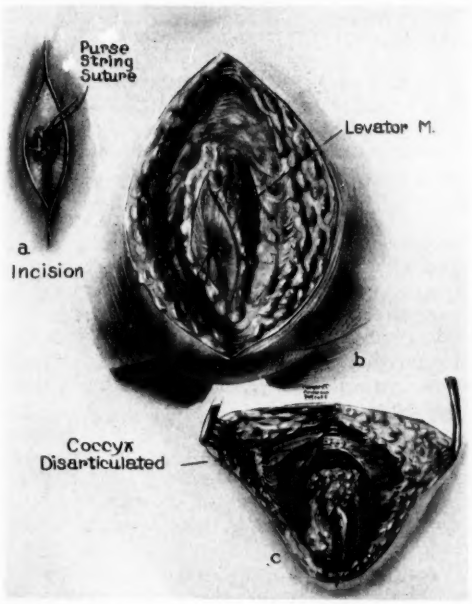

Fig. 5. a, Pursestring suture about anus. Midline incision. b, Flaps dissected back to edge of gluteus muscle. c, Coccyx disarticulated from sacrum and fascia beneath it incised.

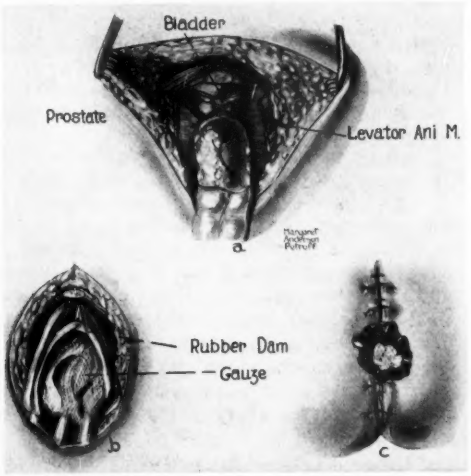

Fig. 6. a, Incision in presacral fascia exposes bowel cavity containing bowel removed from above downward. b, Large square of rubber dam placed in cavity—gauze packed in dam so that it does not adhere to new pelvic floor closure. c, Closure.

to the perineum encircling the anus. If the growth is low lying, more peri-anal skin is removed than when it is located higher up. Flaps are dissected laterally until one encounters the gluteus maximus muscle, and all the structures including the ischiorectal fat are displaced medially. The coccyx is then disarticulated and the presacral fascia incised, thus bringing into the operative field the cavity containing the distal end of the cut off sigmoid. This is pulled out and dissection of the rectum is done from above downward rather than from below upward. It is a simpler procedure and is attended by less bleeding. It must be remembered that an incomplete abdominal dissection renders the posterior operation more difficult.

There remains then, a very large cavity surrounded only by the walls of the pelvis and the bladder anteriorly, and into this cavity we place a large square rubber dam and pack gauze into it, the rubber dam preventing the gauze from adhering to the new pelvic floor which may be torn when the gauze is removed. This large pack helps to support the new pelvic floor and, by its pressure on the surrounding structures, it also prevents oozing. Part of this gauze is removed on the third and part on the fourth day after operation, after which the cavity is irrigated daily with care to prevent infection. The colostomy is opened on the second or third day according to the amount of distention. Formerly, we used a retention catheter for 4 or 5 days, but recently we have not resorted to this unless necessary. We feel that bladder irritability and cystitis have been minimized by this new procedure. Treatment from this point is symptomatic, and we encourage the patient to be out of bed on the twelfth to the fourteenth day because this helps the new pelvic floor to sag, thereby filling in the posterior cavity a little sooner than it would if the patient were in bed for a longer time.

The one stage combined abdominoperineal operation is admittedly a severe one, but it is not intrinsically difficult nor does its performance demand exceptional ability. However, it is not merely a technical maneuver. The surgeon must assume responsibility for meticulous pre-operative preparation. He must plan the operation well. He must direct good postoperative care and finally instruct the patient in the management of the colostomy which is so essential to comfort. The results of this well rounded-out plan have been gratifying. In a personal series of 151 cases, there have been 16 deaths, a mortality of 10.5 per cent. Fifty-two per cent of the patients are living and well for 5 years, 62 per cent for 3 to 5 years, and 70 per cent from 1 to 3 years.

TREATMENT OF CARCINOMA OF THE LARYNX[1]

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IN selecting surgical methods for the treatment of carcinoma of the larynx, definite technical procedures should not be decided upon before operation, except in a limited group of cases in which the growth is well defined. Rather, an exploratory operation should be undertaken first and the surgical procedure that seems best suited to the individual case should then be employed. This selection should depend on the situation of the growth, its extent and type, and on the patient's age and general condition. While the voice must be conserved whenever possible, eradication of the disease is of the greatest importance. In cases in which small early growths involve the anterior part of one vocal cord, thyrotomy and removal of the growth is unquestionably indicated. In cases in which there are more extensive tumors of the epiglottis and aryepiglottic fold, pharyngotomy and removal of the growth is indicated, and for still more extensive laryngeal growths laryngectomy should be performed.

CLASSIFICATION OF TUMORS

The usual classification of carcinomas of the larynx into intrinsic and extrinsic growths, depending on whether they involve the vocal cords and adjacent part of the larynx or whether they extend out over the rim of the arytenoid region or aryepiglottic fold, is of little value in determining operability in these cases or what procedure should be followed in removing the growths. It is well known that growths originating on the vocal cord anteriorly, tend to grow much slower and to metastasize late, owing to the lack of lymphatic drainage. These have been called intrinsic tumors. Growths of the epiglottis and aryepiglottic fold have been called extrinsic tumors and it is usually believed that these tend to metastasize early and that the prognosis is usually much worse for them than for the former. However, while this may be true at times, growths of the epiglottis and aryepiglottic fold often are of a low grade of malignancy, and regardless of their position they tend to metastasize very late, if at all, while a carcinoma of a high grade of malignancy on the vocal cord may tend to metastasize early.

The general classification of laryngeal tumors into intrinsic and extrinsic therefore forms a basis for discussion. But it is not in this manner one considers them in determining the best treatment in the individual case. The growth, which may appear entirely intrinsic, may extend through the thyroid cartilage or the cricothyroid membrane or above the rim of the thyroid cartilage. In about 17 per cent of the cases in which it is necessary to perform laryngectomy, the growth has perforated through the thyroid cartilage or the cricothyroid membrane. It is impossible at times to determine this extrinsic involvement by palpation, by roentgenological examinations, or by any other method.

From the standpoint of methods of removal, growths of the larynx may be divided into 3 groups: (1) supraglottic tumors, (2) intralaryngeal tumors, including subglottic growths, and (3) laryngopharyngeal tumors, those arising in the pyriform fossa and postcricoid region. Many of these growths, however, may involve 2 or possibly all of these regions so that definite anatomical divisions cannot be made.

METHODS OF SURGICAL TREATMENT

In determining the method of treatment for any laryngeal lesion, the question of the type of carcinoma is very important, and, unless one can remove the growth in a conservative way with a sufficiently wide margin, as brought out by New and Fletcher, then a more radical procedure should be followed. Surgical procedures, including excision and surgical diathermy, are the most effective methods of treating carcinoma of the larynx. In the treatment of tumors of a high grade of malignancy, irradiation used before and after operation seems to be of additional value.

Supraglottic tumors. Growths in the supraglottic region may produce few if any symptoms until they are of quite large size. Growths of the epiglottis of a low grade of malignancy may cause difficulty in swallowing as their first symptom. Sometimes an indeterminate ache or pain in this region may bring the patient for examination. Until these growths have extended into the larynx, hoarseness is not a symptom.

Tumors of the epiglottis of a low grade of malignancy are best taken care of when the lesion is definitely limited to the epiglottis by performing preliminary tracheotomy. Then, by means of a Lynch suspension apparatus with a flat spatula, the growth may be removed under direct vision.

[1] Presented in the Cancer Symposium, before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

a protected diathermy point being used. This particular method, however, should be limited to cases in which there is no question that the growth can be removed in this manner. In cases in which the growth extends laterally to the aryepiglottic fold and the arytenoid region, subhyoid or lateral pharyngotomy is a better procedure. The question whether to perform pharyngotomy through the thyrohyoid membrane after division and retraction of the hyoid bone or lateral pharyngotomy must depend on the situation and extent of the lesion. In this way wide exposure can be made and as radical an excision performed as is necessary. In these cases a window may be removed from the thyroid cartilage on the uninvolved side; in this way sufficient exposure can be obtained and the growth can be destroyed through this opening on the opposite side of the larynx. The transmandibular and translingual exposure as used by Trotter to remove an epiglottic growth, we believe, has a very limited field. The other methods are far more efficient, and from them the patient will receive less general reaction.

Growths of the epiglottis occur more frequently on the posterior surface, and epitheliomas are the most common of the malignant tumors. A fibrosarcoma may occur in this region, and it is best removed by destroying it under suspension, by surgical diathermy following preliminary tracheotomy.

Carcinoma of the epiglottis may fill almost the entire hypopharynx, so that only a margin of the larynx is visible. This type of growth, however, tends more to be an excrescence, appearing like a cauliflower that has gone to seed, and it may have a fairly limited attachment. The treatment of this type of growth, of course, must be entirely different from that employed when the growth is infiltrating. With supraglottic tumors of a low grade of malignancy, one is justified in being fairly conservative because of the fact that in these cases, if it is possible to remove the growth, the patient has a good speaking voice.

Carcinoma of the epiglottis may extend not only onto the aryepiglottic fold, but into the pyriform fossa and lateral wall of the pharynx, so that laryngectomy together with removal of tissue involving the pharynx may be necessary. As has been said, it is essential that the technical procedure to be followed should not be definitely determined before the tumor has been explored, as extension may frequently be found which would have been impossible to determine before operation. These epiglottic growths may also extend to the postcricoid region.

Intralaryngeal tumors. Growths of the glottis cause hoarseness as an early symptom so uniformly that adult patients who are hoarse over a period of a month should be carefully examined to make sure that the hoarseness is not due to a malignant condition. In examining such patients, various types of so called precancerous lesions are found, such as thickened leucoplacias, and so forth. In cases in which the leucoplacia is markedly thickened, we feel that wide excision of the lesion by means of thyrotomy is advisable. Biopsy should not be made because it may show a benign condition and the patient then feels that removal is not essential. On the contrary this type of condition is potentially malignant and the lesion should be removed widely. There is a very small group of these precancerous lesions, however, that may be removed by means of suspension laryngoscopy. In general, however, the larger lesions of this type are better widely removed and the base destroyed with surgical diathermy by means of thyrotomy.

Malignant lesions in the region of the vocal cords may be taken care of in 4 ways: Those involving the anterior two-thirds of the vocal cord without fixation may be removed by means of thyrotomy, with excision of the growth and destruction of the base by surgical diathermy. Those involving the same region but with such fixation that the growth has not perforated through the thyroid cartilage may be removed by means of thyrotomy, the growth being removed along with the cartilage and the tissue being destroyed by surgical diathermy. Growths in the anterior commissure are best taken care of by division of the hyoid bone, the opening being made through the thyrohyoid membrane. In this way a careful examination can be made as to the exact extent of the growth. In the treatment of tumors of a low grade of malignancy, thyrotomy is performed, with removal of the diseased tissue which frequently involves the anterior portion of both vocal cords and the anterior commissure. This method was suggested by Jackson and is very efficient in the care of tumors of a low grade malignancy. In the treatment of more extensive tumors with fixation involving the anterior commissure and the false cords, laryngectomy is done; preliminary tracheotomy is done first and then, as a secondary procedure, the larynx is removed from below.

When laryngectomy is done, we use paravertebral anesthesia, and we prefer the midline incision. We then divide the hyoid bone and retract it laterally with rake retractors. The larynx is freed up from the muscles, first on one side and then on the other. On account of the possible

extension of the growth through the thyroid cartilage or the cricothyroid membrane, it is essential that this dissection be made very carefully. If there is any question of extrinsic involvement at this point, wide excision, either with a knife or cautery, is advisable. The trachea is cut across below the growth and procaine is then injected into the posterior wall of the larynx and trachea. If the extent of the growth will permit, a tongue-like flap of mucous membrane and submucous tissue is dissected free from the posterior wall of the cricoid cartilage, leaving it attached to the tracheal mucous membrane. This aids in closure of the skin to the trachea. It is necessary to inject some procaine into the pharynx after the trachea has been cut across, as it is difficult to block this area with paravertebral anesthesia.

Dissection is then carried up onto the posterior wall of the larynx. The pharynx is opened, and in cases in which there is some question as to the posterior extension of the growth, exploration is made with the finger at this time. The larynx is then removed. The opening into the pharynx is closed with 2 layers of fine, chromic catgut sutures. The trachea is sutured to the skin by means of silk sutures. One mattress suture just above the trachea is carried through the anterior wall of the esophagus in order to bring it forward against the skin. Mattress sutures are used in closing the lower 5 centimeters of the skin above the trachea. Rubber cigarette drains are carried into the pockets on either side and an iodoform gauze pack is placed in the upper part of the wound. A No. 7 tracheal tube is inserted and a dressing is applied over the upper part of the neck.

Little reaction occurs following the procedure we have outlined. The temperature usually does not go above 100 or 101 degrees Fahrenheit for about 4 days and then comes down to normal. The drains are removed gradually; they are usually out about the tenth day. In a large percentage of cases, the closure about the posterior wall of the trachea and lower 5 centimeters of the incision almost heals by primary intention. A small pharyngeal fistula at the upper end of the incision is frequently freshened up, after the wound heals sufficiently, and is closed with mattress sutures. The tracheal tube is usually removed about the fourth day and kept out the greater part of the time unless there is some tendency for the tracheal opening to close. In this way less reaction occurs about the upper end of the trachea.

Age should not be a factor in determining the question of malignancy, as we have had to perform laryngectomy in the case of a boy 16 years of age and in that of a man 77 years of age. While carcinoma of the larynx is less common among women, we have had to perform laryngectomy on a girl of 20 years. In regard to the question as to removal of lymph nodes in these cases, we do not do a routine block dissection of the neck of patients who have cancer of the larynx without glandular involvement. In cases in which there is glandular involvement of low grade, we feel that this procedure should be followed.

A patient who underwent laryngectomy 18 years ago and who had palpable lymph nodes illustrates the value of block dissection in such cases. At the time of block dissection, 2 lymph nodes were involved in the neck, and squamous cell epithelioma of grade 2 was diagnosed. The patient had no recurrence in the neck but died 15 years later of adenocarcinoma of the stomach. The gastric lesion had no relationship to the laryngeal growth. Patients with soft, rapidly growing metastatic lymph nodes are much better treated by irradiation, whereas a patient who has hard, shotty lymph nodes is better taken care of by block dissection followed by irradiation. Frequently, however, one will be surprised by the results of block dissection and irradiation, even in cases in which tumors are of a high grade of malignancy. For example, a patient was operated upon and treated by irradiation for a carcinoma, grade 4, of the floor of the mouth, with metastasis to the cervical lymph nodes. The patient returned 10 years later in excellent general condition and with no recurrence, which, of course, is not the rule in such cases. We have not used the method of inserting radium into the growths following removal of the cartilage, as advocated by Ledoux, Harmer, and Portmann. We feel that these cases are much better taken care of by surgical measures along with irradiation.

The results of treatment of carcinoma of the larynx have recently been reported by New and Waugh. In a consecutive series of 135 operations for carcinoma of the larynx, 75 thyrotomies and 60 laryngectomies, there was 1 death. In reviewing a series of 107 patients who were operated upon prior to 1929, they reported that 5 year cures were obtained in 82.3 per cent of the cases in which thyrotomy was performed and in 56.1 per cent in which laryngectomy was performed. It was found that the average time elapsing since operation in these cases was 9 years and 4 months, the shortest time being 5 years and the longest, 24 years. A review of the cases in which the growths had been graded microscopically showed that none of the patients with carcinoma of grade

4 was living 5 years later. We are now treating such patients by giving them deep roentgen treatment, performing laryngectomy 1 month later, and following this again by deep roentgen treatment. This, of course, makes a much more difficult procedure technically but apparently is producing better results. We have 2 or 3 patients who are well now between 4 and 5 years after operation, and we anticipate that this type of treatment will produce better results than can be obtained by surgery alone. We have recently seen a patient on whom Dr. C. H. Mayo performed laryngectomy 25 years ago, and this patient is perfectly well.

In addition to the epithelial tumors of the larynx one occasionally sees an adenocarcinoma. In this type of case the lesion may be removed surgically, following preliminary tracheotomy, in the same manner that one would remove a mixed tumor of the pharynx or parotid region.

Sarcomas of the larynx are more unusual. Figi recently reported 6 cases and New reported 2. These usually tend to be of a low grade of malignancy. However, we do see those that are of the active fulminating type. We have never seen a patient with an active type of epithelioma for which irradiation was used, where the patient stayed well over a period of years. Some sarcomas, like one we recently treated, are pedunculated; this tumor filled the entire larynx and preliminary tracheotomy had to be done. The tumor, which was attached only to the anterior portion of one vocal cord, was removed and the base destroyed by diathermy. Microscopically it was a fibromyxosarcoma, of grade 4. There has been no recurrence in 1½ years, so that all highly malignant tumors apparently do not require radical removal if they are pedunculated.

It is possible in the treatment of chondrosarcoma, to shell them out completely. They vary in malignancy from those which are little more than chondromas, to very active malignant types. Some of them extend well into the trachea and it is impossible to remove them in capsule. One must rely in these cases on irradiation.

Laryngopharyngeal tumors. The postcricoid tumors are practically all squamous cell epitheliomas of grade 4, and in our experience, metastatic involvement of lymph nodes is usually present at the time of examination. These lesions usually occur among women. Trotter's method of taking care of them is the treatment of choice; however, the prognosis for these highly malignant tumors in this region is such that surgery offers little except in a limited group of cases. We have seen these highly malignant tumors completely disappear under irradiation but the patients stay well for only a little more than a year.

We recently operated on a patient with a postcricoid tumor, squamous cell epithelioma grade 3, somewhat pedunculated, that was attached to the posterior wall of the pharynx and upper part of the esophagus. Following tracheotomy, we performed transthyroid pharyngotomy and were able to remove the tumor by means of surgical diathermy. The patient was well and without recurrence 1½ years later.

In some cases in which the growth is fixed to the posterior surface of the larynx, without involvement of the rest of the upper part of the esophagus and without any lateral extension, it is possible to perform laryngectomy and save the upper part of the esophagus. In this way closure may be made without requiring a flap of skin, as in the Trotter operation.

Tumors of the pyriform fossa are usually of a high grade malignancy and, like postcricoid tumors, usually metastasize early. In general, irradiation offers more than surgery, as these growths usually do not produce symptoms early enough to bring the patient for examination when surgical measures are worth while.

CONCLUSIONS

In the treatment of all malignant lesions of the larynx, it is essential that the individual case be carefully studied and that no definite technical procedure be fitted to the case until the larynx is explored, and the best method of completely removing the diseased tissue ascertained. The method chosen should leave the patient with a good voice when it is at all possible.

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THE DIAGNOSTIC CANCER CLINIC IN A PRIVATE HOSPITAL[1]

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IN 1900 cancer stood sixth as the cause of death in the United States. At the present time, deaths from cancer stand second only to heart disease in total mortality rates.

With the beginning of the present century, extensive research and experimentation advanced so rapidly that it is now impossible for any individual to be a master of all branches of medicine. Specialists have appeared and special groups for the diagnosis and treatment of various maladies, including tuberculosis, venereal disease, diabetes, etc. It is a well known fact that cancer may attack any part of the body and be characterized by various types of tumors. The patients in clinics and in charity hospitals have had the advantage of being studied by specialist groups. Private patients, however, were not always so privileged. In 1928 therefore the malignancy committee of the Hollywood Hospital was formed to try to bring the benefit of group opinion to the private patients.

One of the first requisites in the management of a malignancy case is diagnosis. Due to inadequate facilities for training, or because of the sparsity of cases, the number of cancers seen by the average physician and surgeon each year is usually not over 5; therefore, physicians and surgeons individually have little opportunity to become proficient in the diagnosis of malignancies in the early stages.

It has been well pointed out by previous writers on the subject that the avoidable delay elapsing from the time the patient first notices his or her tumor, to the time of seeking medical advice, is 4 months. It has also been pointed out that the avoidable delay, after the first examination by the physician to the time that the patient receives proper and efficient treatment, is 3½ months, so that the total avoidable delay time throughout our country averages 7½ months before correct treatment is instituted. The taking of biopsies is feared by many physicians and many are not equipped to make them. Physicians as a whole seem somewhat hazy in their opinions as to proper forms of treatment in certain given malignancies. Group examination and opinion is therefore more quickly sought by the physician for his patient if these groups or clinics are available for use. The patient is usually much impressed by a group examination, is also more willing to accept the situation as it is found, and will therefore not wander from one physician to another seeking further advice.

Treatment must be not only prompt but adequate. A little treatment because a lesion *may* be cancer is unjustifiable. The original treatment must be carefully planned and then meticulously followed. Secondary treatment after failure of the primary is rarely successful.

There is no doubt as to the benefits of group opinion in malignancy; our problem has been to apply this method in a private hospital.

The malignancy committee of the Hollywood Hospital began to function in 1928 and has continued to the present time. Meetings are held once each week. The personnel of the committee has changed very little since its inception, being composed of 5 members: a general surgeon, a gynecologist, an internist, a pathologist, and a radiologist. The committee elects its own chairman, vice-chairman, and secretary, annually. The record nurse and malignancy interne are appointed by the hospital, as is also a consulting staff, consisting of a proctologist, oculist, aurist, dermatologist, urologist, and plastic surgeon. The consultants are not required to attend the regular weekly meetings, but are required to examine patients referred to them, and report their findings in person or in writing at the next meeting.

The routine procedure of the committee is as follows: Patients are referred to the malignancy committee by any regular physician by card or letter. A history is taken on the regular malignancy form by the malignancy interne and this history is read in the committee room while the patient is being prepared by a nurse in the examining room. After the patient is examined, the case is immediately discussed in the committee room. Special laboratory work, X-rays, or special examinations, if needed, are requested of the referring physician. But, as a rule, he will direct that such work be done at the hospital. Biopsies are taken, with the consent of the referring physician, by one member of the committee and the findings are reported by the committee pathologist.

After full discussion of the case examined and completion of a diagnosis, the committee then jointly arrives at the most appropriate treatment. This method lends definite individuality to both diagnosis and treatment of each case. The chairman then dictates a letter to the referring physi-

[1] Presented in the Cancer Symposium, before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

TABLE I.—STATISTICS OF MALIGNANCY COMMITTEE, HOLLYWOOD HOSPITAL, JANUARY 1, 1929—JULY 1, 1935

Year	New cases	Patient visits
1929	108	157
1930	110	193
1931	127	236
1932	162	401
1933	225	530
1934	237	459
1935—to July 1st	108	173
Total	1077	2149

TABLE II

	Number
Patients referred by doctors on Hollywood Hospital staff	809
Patients referred by other doctors	182
Patients not referred by any doctor	86
Cases referred by 251 physicians	991
Physicians referring from 10 to 45 cases each	23
Committee meetings from January 1, 1929 to July 1, 1935	332
Hours consumed in meetings	750
Letters written to physicians	1115
X-ray pictures taken of breast cases for diagnosis	400
Papers on cancer read outside hospital	15
Papers on cancer read before Hollywood Hospital staff	20
Cancer clinics held before Hollywood Hospital staff	4
Annual meetings of the American College of Surgeons attended by delegates	4
Annual meetings of California State Medical Society attended by delegates	3

cian and the patient is directed to call on his or her physician in 2 days. No information whatever is given to the patient either verbally or in writing. Letters to physicians are descriptive of the lesion found with definite attempts being made to give a concrete diagnosis, with the committee's suggestion as to treatment of the case.

Records on all cases are kept on file, with a follow-up. These records are available for statistics and reference work both by the committee and the patient's physician. In cases entering the hospital after examination by the malignancy committee, a copy of the consultation letter is attached to the history on admission. Following any operation or treatment given, case copies are transmitted from the hospital record office to the malignancy file of this patient. This includes all pathological, X-ray, and operative reports.

Treatment of patients is undertaken by members of the committee only on the written request of the physician referring the case.

When the committee has had an unusually difficult case all the data is collected, including laboratory slides, X-ray films, etc., and these, with descriptive letters, are sent to cancer centers elsewhere, for advice. The staff of the Memorial Hospital in New York has been most generous in assisting our committee in these complex cases. By using air mail we are enabled to receive a reply from this hospital in 1 week. This aid has been much appreciated, and we wish to express our thanks to the staff of the Memorial Hospital for their generous advice.

We do not feel that the formation of cancer committees or tumor clinics in hospitals produces cancer phobias, no more so than does the publicity given tuberculosis and various other diseases. We do feel that a cancer clinic is of great importance to physicians of the community and to the internes of the hospital. Physicians referring patients, or visiting the clinic meetings, of necessity are better able to recognize early cancer and will continue to become more cancer minded in their daily routine.

TABLE III.—COMPILATION OF TOTAL CASES FROM JANUARY 1, 1928—JULY 1, 1935

Type of case	Total number	Malignant	Non-Malignant
Breast	292	124	168
Cervix	134	63	71
Uterus	70	19	51
Vagina	11	2	9
Vulva	7	3	4
Pelvis	32	15	17
Rectum	40	28	12
Colon	9	6	3
Stomach	16	11	5
Esophagus	3	2	
Liver	6	5	1
Lung	7	3	4
Mediastinum	4	4	0
Pancreas	5	5	0
Genito urinary	26	11	15
Bone	18	9	9
Skin	32	12	20
Hemangioma	13	0	13

TABLE IV

Type of case	Total number	Malignant	Non-Malignant
Ear	9	6	3
Eyelid	12	7	5
Face	80	53	27
Jaw	8	6	2
Lip	59	27	32
Nose	50	19	31
Mouth	29	11	18
Throat	12	8	4
Tongue	49	15	34
Scalp	5	2	3
Neck	28	16	12
Parotid	5	3	2
Branchial Cleft	1	1	0
Thyroid	3	0	3
Melanosis	3	3	0
Carcinomatosis	4	4	0
Sarcomatosis	6	6	0
Miscellaneous	84	9	75
Total	1172	518	654

Reference of suspected malignancy cases to the malignancy committee is purely voluntary on the part of the staff. Some staff doctors are self sufficient and do not wish advice; others are fearful that asking or taking advice will belittle them in the eyes of the patient or that they might lose their patient. On the whole the response of the Hollywood Hospital staff has been more than satisfactory as shown by the number of patients referred. Twenty per cent of the total number of patients examined thus far have been referred by physicians not on the Hollywood Hospital staff. These outside physicians are also frequent visitors at the regular meetings.

The economics of a diagnostic cancer clinic in a private hospital may be summed up briefly as follows:

No financial burden should be placed on the hospital *per se*. The physicians forming the committee are without compensation, and any routine biopsies or minor laboratory procedures are referred to the pathological laboratory and reported without charge, as also are small X-ray films. Three rooms are placed at the disposal of the committee by the hospital, together with nurse and recording secretary, without charge.

Patients referred to the committee on their first visit are handed a slip of paper, upon which is written a statement in two paragraphs, telling the functions of the committee, and asking for donations to defray necessary expenses, including printing, stenography, histories, etc. These donations have varied from twenty-five cents to one thousand dollars.

There are certain physicians who, after a diagnosis of malignancy is made on their patient, refer the patient back to the committee for recommended treatment. These patients, if hospitalized, are treated as committee cases and an appropriate fee is charged to cover all necessary hospital expenses. Any remaining fee is credited to the malignancy committee fund. Gratuitous services rendered, as stated, have apparently repaid the hospital many times, in that a large majority of these patients have been hospitalized in the Hollywood Hospital for the treatment suggested by the malignancy committee. Therefore, the administrative departments of private hospitals should assume a very optimistic attitude with regard to recompensation for gratuitous services given by their full time pathological, X-ray, or nursing departments.

The malignancy committee fund is used in the purchase of essential stationery, films, photographic apparatus, and there have always been funds available, sufficient to repay expenses of one member to the annual meeting of the American College of Surgeons. This member in turn is expected to spend the majority of his time at the convention in cancer work and it is his obligation, on his return, to present to the committee and other interested physicians, a formal report of knowledge gained.

SUMMARY

The malignancy committee of the Hollywood Hospital believes that:

1. The diagnosis and treatment of cancer is a specialized subject and not one in which the majority of the physicians and surgeons have the opportunity to become proficient.

2. The diagnosis and advice as to treatment by a group of cancer minded physicians acting in unison, with adequate diagnostic facilities, make for efficiency in protecting the interests of both the patient and the patient's physician.

3. The avoidable delay time before proper treatment is instituted, which is now approximately 7½ months, must be cut down appreciably before our results will show improvement.

4. Accurate diagnosis, by biopsy if possible, should be made before treatment is instituted and that treatment must be prompt and adequate—a little treatment because of a little doubt in the diagnosis is unjustifiable.

5. The life of the cancer patient depends on the first physician who sees and treats him; secondary treatment after failure of the primary treatment is rarely successful.

6. The diagnostic cancer clinic is practical and workable in an accredited private hospital so long as the rules and ethics of medicine are followed.

The accompanying tables give statistics covering the work of our committee.

SYMPOSIUM: TREATMENT OF FRACTURES

THE CAUSES OF NON-UNION: BONE GROWTH AND REGENERATION[1]

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PHILOSOPHY constantly seeks new fields for investigation. It is, without question, the driving force of the universe, always turning, twisting, and struggling in an effort to go forward, to make things more perfect and to discover new and imperfect things that it may perfect. In other words, philosophy is insatiable and we must endeavor to support any study or investigation that will increase our knowledge and make surgery and medicine more exact sciences. But the efforts to perfect our knowledge must not be allowed to obstruct our use of those facts which we know to be true. This paper is an effort to correlate the known facts about bone growth and place them in a workable formula.

When an investigation of this subject is undertaken, one is confronted with an almost unbelievable chaos, brought about by the confusion of terms and the multiplicity of conclusions, in many instances the conclusions being drawn from insufficient data.

While it is acknowledged by most physiologists that bone can and does grow, the great argument in their minds is what makes it grow and from which of its 3 major components is the greatest growth obtained. There is no doubt whatever, either in the mind of the physiologist or of the surgeon, that, when the shafts of 2 fragments have been denuded of periosteum and are approximated, the cortical bone or osteogenic layer rapidly produces bone and a very firm union takes place. And the firmness varies with the area of approximation. "Femurs of heavy men with 2½ inches overlapping are firmly united in 6 to 8 weeks." Hence the statement is still present in so many textbooks as to the length of time required for femoral union.

But, when 2 fractured femoral fragments are approximated, one covered with periosteum and the other denuded of periosteum, another problem is presented, in that the union depends entirely upon the ability of the denuded bone cortex to produce a shelf upon which the other fragment may rest, while the intervening periosteum is absorbed or destroyed. Or, if the non-denuded sides of both fragments are approximated after the force has ceased and the treatment has been instituted, a non-union is the common result. The open ends of this fracture will absorb bone fragments, produce some bone, and seal the ends, but there will be no union.

In these types, which every surgeon encounters at different times, there are certain very definite facts that make themselves evident. The first is that cortical bone will grow and grow rapidly. The next is that the periosteum can and does block efforts at union when the conditions are not favorable. These facts do not mean that the bone will always grow or that the periosteum will always inhibit growth. The bone growth from the ends of the fragments is always slow, because at the point of fracture there is always a layer of so called dead bone and this must be mobilized and utilized before a union can take place. In the ends of femoral fragments, these being the largest bones, we find the greatest amount of so called dead bone. Or to put it in what our clinic thinks to be the best description, the layers, or borders, or edges of bone fragments are devitalized to the extent that bone cells in the lacuna will not take the hematoxylin stain. And these ends and the fragments are without doubt in a resting stage, but are not dead in the sense that a piece of boiled bone is dead. We are firmly convinced that this dormant bone is present to a greater degree in the femur than in any other bone, because of the fact that for many millions of years femoral ends were seldom, if ever, approximated, and the accustomed manner of healing has been by an overlapping and cortical contact. We are convinced that the end-to-end reduction of transverse fractures of the femur by traction and manipulation requires from 30 to 50 days longer to obtain a firm union than any other type of femoral fracture. This delay, which is caused by the readjustment of the so called necrotic or dead end, or, as we prefer, the dormant end, excites many surgeons to examinations and manipula-

[1]Presented in a Symposium on Fractures, before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

Fig. 1. J.J.C. Marked development of detached periosteum in an adolescent. The epiphyseal lines are still visible. The periosteal bone is more dense than the bone adjacent to the shafts.

tions that may destroy the new callus and cause a non-union. We do not mean to infer by any means that a crack or breaking of the callus will always cause a non-union, because such is not the case. But repeated manipulations and multiple readjustments are certainly a factor in the production of non-union. Surgeons should realize that many transverse or slightly oblique fractures of a femur require from 90 to 120 days for firm union, if the ends are correctly approximated. Possibly if the traction could be so adjusted that the tone of the muscles could make normal pressure without permitting a bowing of the bone, a firmer and more rapid union might take place.

The speed of bone proliferation and the firmness of union in oblique fractures, in which there is no interposition of tissues, causes us to wonder if there is a layer of devitalized bone in this fracture, parallel with the haversian canals, of equal depth to that on the ends of transverse fractures. We could not find articles of proof either in animal experiments or in observations upon the human.

That injuries may be so terrific that the periosteum may be torn into many ragged fragments or torn from the bone as a whole, leaving one fragment completely denuded, there can be no doubt, as we have observed both types. That there are any number and types of variations must be admitted as possibilities. Now, if one fragment is torn out of its periosteum and the periosteal tube twisted to cover the non-denuded end, a non-union is almost certain to result. On the other hand, if one torn flap of periosteum and attached fascia and muscle is placed between the bone ends, it will tend to inhibit and delay bony union, because as far as we can determine from the literature and observations, only one side of the periosteum will produce bone.

So much for the periosteum as an inhibitor of bone growth. It should be stated, however, that the picture produced by strips of periosteum elevated from each fragment and the luxuriant growth of callus between it and the fragments, convinces most observers that when conditions are favorable periosteum is of the greatest aid in callus formation. We, however, have never observed a detached strip of periosteum in an elderly individual growing bone at a distance from the fractured bone, whether it was or was not attached at one end. The reader must be careful not to get this finding confused with the wild growth of bone so commonly seen around the elbow, as that apparently is from an unknown and very different cause.

In young people, periosteum detached from the shelf adjacent to each bone fragment will, not uncommonly, show a growth of bone immediately attached to the periosteum with a relatively smaller and less dense amount of bone in the area adjacent to the cortex (Fig. 1). This very rarely occurs in the adult. As just stated, however, a strip of periosteum adherent at one end with the other end widely displaced from the fracture, has never, in our experience, shown a growth of bone at its distal portion.

Another factor that must be considered is injury to the blood supply of the bone with the periosteum intact or with an avulsion of the periosteum. So far as we have been able to observe, interference with the blood supply alone causes little disturbance. This means that under ordinary circumstances, fractures at or near the nutrient artery heal just as well as those distal or proximal to it. But when the fractured end, distal or proximal to the nutrient vessel which has been injured, is also denuded, it is common to have non-union; and at the time of operation the surgeon will expose one of the fractured ends of the bone which will be white with a slightly pink color showing through the white, the edges rounded and the loose fragments absorbed, but no evidence of any effort at bone proliferation from this fragment. The bone is alive but dormant, and a slow union may be prognosticated, irrespective of the method used in the repair. It is well to state here that a bone fragment that is well nourished is of a rich, dark red color, with blood oozing freely

from multiple small points. These pale fractured ends which we have designated as dormant are most commonly of an oblique or spiral type, but we have encountered one transverse fracture in which three-fourths of the cortical area presented the findings described. It is well known that the condition described in the dormant ends is commonly found in detached fragments, but we wish to emphasize strongly that this condition also occurs in the fractured end or ends of bone which have had their vitality interfered with by an injury to the blood supply and an avulsion of the periosteum. In this type of dormant bone, the cells may or may not take a normal hematoxylin stain. We have not observed a sufficient number of cases to be certain, and in those observed we have had difficulties with our specimens which we hope to overcome. Good roentgenological studies will show that the dormant fragments are much more dense than the normal fragments.

Non-union following an early open operation with steel plates, ivory or boiled bone plates, onlay or intramedullary grafts of autogenous bone in many instances will be traced to this dormant condition of one of the fragments. This dormant condition can be present as a result of the accident itself or as a result of the ruthless sacrifice of the periosteum at the time of operation. However, if this condition is encountered in non-union and there is also some interposition and an exuberant callus from the other fragment, the new callus when approximated to this bone, seems to adhere quickly to the dormant bone and, we think, stimulates it to growth.

We are convinced that there is less dormant bone on the ends of a transverse fracture of the humerus than on the ends of femoral fractures and that these ends will grow new bone much more rapidly than any other bones in the body, possibly because, in our millions of years in the upright position, they have been much more frequently brought end-to-end where the broken fragments have been brought into apposition or slightly separated by the weight of the pendant distal portion of the upper extremity.

In explaining why cartilage is a common accompaniment of bone growth, do not forget that as life evolves bone is far more recent than cartilage and has been developed by the organism when a more rigid supporting structure is necessary. The beginning of bone is a calcium deposit in cartilage; later a bone structure becomes organized in the calcium deposit. These same steps are found in the healing of different types of fractures, the process varying with the blood supply; in our opinion, these steps have no clinical significance.

Up to the present time we have dealt with non-union from an anatomical standpoint, but we are now ready to present something upon which to prognosticate a non-union at the time the patient is brought into the hospital. While, as a rule, the history, as far as it concerns the production of a fracture and as related by the individual, has little value, the history obtained from the patient and from other observers should be of great value. It must be determined how long the force that produced the fracture continued to act, for it is the continuation of the force that has caused the interposition of tissues, that injures and destroys the periosteum, that causes its twisting and being torn to bits, as well as injures the blood supply of the bone and the adjacent tissues. It is a simple thing for an individual to crack a leg or an arm, have it immediately put to rest, and obtain a union. But if that arm is caught in a belt and jerked around a pulley many times with its possessor following after it, a union is far less likely to occur. To use another example, suppose there is an automobile accident. The thigh of one of the car occupants is fractured at the moment of impact; the automobile turns over two or three times and in the end, the individual is thrown out. During these movements he is shaken around in the car like a pea in a pod and obviously, the limb is twisted into every possible angle during that shaking up. These are examples of what is meant by the continuation of the force following the reception of a fracture. These factors are the common causes of interposition and devitalization of bone fragments, and these, in our opinion, are the commonest causes of non-union.

Messy manipulation and frequent interferences in the treatment are other vital factors. These manipulations and interferences with the growth of the callus are frequently stimulated by the fact that the X-rays fail to show the growth of callus. We have repeatedly observed firm union in which no callus was visible in the X-ray plates. We wish to caution the reader not to place too much stress upon the X-ray evidence as to the absence of callus. We have operated repeatedly with the idea that there was little, if any, callus present and have found a well developed callus. We have examined patients in whom callus was reported absent in the X-ray film and yet we have found union present. If in doubt, wait and do the least possible amount of handling and manipulation.

We have observed other cases particularly in the upper 4 inches of the tibia in which the force was not great enough to cause displacement of fragments and an interposition of tissues, or to interfere seriously with the blood supply, and yet

Fig. 2. M.T., 8 years of age. Congenital non-union of both bones of the left leg. At 8 years of age grafts were taken from the right tibia, which is shown in this illustration, and the site from which the graft was removed has regenerated new bone and some excess bony growth. This is to be expected in all children. At a subsequent operation, a small piece was taken off of the proximal fragment of the un-united tibia. In this abnormal bone, there has been no effort whatever at regeneration, either at the spot where the graft was removed or where there should be union with the grafts; yet the grafts from the right limb have lived and increased in size with the growth of the individual.

Fig. 3. J.F., 18½ years of age. The defect in the tibial crest, anterior and lateral views, 4½ months following removal. No effort at regeneration.

there has been non-union, due to the fact that the bone just did not grow. It is the one place in which a fracture has occurred and we have been able to be certain that there was no interposition, yet a non-union has resulted. Without manipulations or any other factor we were cognizant that there might result a non-union.

Multiple fractures as a cause of non-union are well known but we believe that these fractures do not unite because of a continuation of the force and interposition, rather than because of the multiplicity of bone injuries.

Most of our repair of non-union and malunion has been accomplished with onlays and intramedullary grafts. We have not been particular about the preservation of the periosteum on the graft but we have been very particular about the periosteum on the fragments where there was to be an onlay or intramedullary graft; removing only as much periosteum as was necessary to make a bed where the onlay was to be applied and not removing the periosteum from bones where the medulla was to be injured by an intramedullary transplant. However in the future, where we use onlay grafts we shall preserve the periosteum, because without question, the connective tissue and periosteum, when transplanted, do not die. Evidence is accumulating that the fragment will receive an earlier and better blood supply if the periosteum is allowed to remain intact. We have used detached strips of periosteum in an effort to aid the proliferation of bone in cases of non-union, where we have used an autogenous bone graft, but as yet we have never seen it show any evidence of bone proliferation or thought that it aided bone proliferation in any manner.

The intramedullary grafts are all autogenous, roughly triangular in shape, and seldom, if ever, fixed firmly in the canal. We are sure that they do better if they are firm rather than loose but we have fear of a necrosis of the cortex if they are driven in too tightly. However, we can say that we have seen no cortical necrosis if the periosteum has been left intact, even if the graft has been firmly driven into the medullary canal.

In relation to the life or death of these transplanted fragments, it is definitely known that all of the adult bone cells are dead, shrunken, and shriveled, as is shown by the hematoxylin stain. But we are firmly convinced that there is life in a transplanted fragment, and it remains for our in-

Fig. 4. M.P., 29 years of age. Defect in the tibial crest from which fragment had been removed 18 months previously. No effort at regeneration.

Fig. 5. F.M., 65 years of age. Tibia from which grafts were removed 5 years previously. Shaft is thinned and narrowed. No regeneration.

vestigators to devise some manner by which this life can be demonstrated microscopically. These fragments retain their same shape, they become pale with a little pink showing through, and later on they become firmly adherent to the adjacent bone and other structures. At a later period when the structures adjacent to them are removed, they will bleed and at the same period, if fractured, they will reproduce bone. As Ryerson says, "If, like the autogenous graft, I can retain my same shape, feed, and reproduce, death will have no sting."

If these autogenous fragments are boiled for one or more minutes, none of the phenomena mentioned will be observed; it is a true sequestrum and will remain such; it will absorb fluids and after several weeks or months will cast a very faint shadow as compared with the shadow cast by normal bone. It is frequently firmly adherent to the surrounding structures and seems to be less irritating than a metal fragment, but it never grows, never bleeds, and never reproduces bone. Absorption of boiled bone has been observed experimentally and does occur in the human animal, but it is not common and cannot be prognosticated. As to which cell is osteogenic and which is not, we have no brief but we are firmly convinced that the cells between the cortex and the periosteum are the most vital factors in the reproduction of bone. Whether these cells are derived from the inner layer of the periosteum or from the cortical bone, we do not know. Nature is obviously cognizant that the adult bone cell in its lacuna is useless and so permits it to die. But no one has been able to observe the activity of one of these bone cells freed from its lacuna.

Now to discuss the area from which autogenous bone grafts have been taken: A number of radiologists and orthopedic surgeons with whom I have spoken are positive that this area will fill with normal bone at an early date. Most of these men, however, have been judging this bone replacement as it occurs in young people. We also have seen the bone replaced in young persons. Figure 2 shows the right tibia from which multiple grafts have been removed, and yet this bone has refilled the spaces from which the fragments have been taken and has added an excess of bone. In the

Fig. 6. J.H., 55 years of age. Rectangular area removed from flat surface of tibia to repair lateral condyle. Very slight regeneration.

other leg, where the graft has been planted, it can be seen that the graft has grown but along with its increase in size, it has retained its same shape, although it has not formed a union with either the upper or lower fragment. In the edge of this tibia to which the graft has been applied may be seen an area from which a fragment has been removed, and at the end of 5 years that fragment has not been replaced; the defect remains the same. This child was 8 years of age when the fragment was removed. The last picture, which still shows the defect, was taken when she was 15. The normal bone has refilled its space and the congenital non-union is running true to form and has not produced bone.

Figure 3 was taken 4½ months after a bone graft had been taken from the upper end of a tibia. The patient was a boy 18 years of age. The edges have been smoothed off and yet no effort at bone reproduction has been made. This is the youngest individual we have had who has failed to reproduce and refill a bone defect.

In no adult have we observed the regeneration of the anterior tibial border from which a fragment of bone has been removed (Figs. 4 and 5). Where the anterior surface of the tibia has been removed in order to obtain a transplant and the medulla has been uncovered, we find that a very thin layer of bone has regenerated. This layer is so delicate in the middle of the defect that an artery forceps can be pushed through it; it is a little heavier around the edges but it never reaches anything approaching the full depth of the original cortex (Fig. 6). The edges of these areas are all smoothed off and the detached fragments absorbed, but no bone growth occurs to obliterate the space. It has made no difference whether these fragments were removed with a saw, in which case heat might have been a factor, or with a chisel where no such lethal factor could be considered. We have had fractures occur in 2 of these cases from which fragments have been removed for grafts. Strange to say, they entered the ward within a week of each another; they were the first cases of the kind we had ever seen, and, though a year has elapsed since they entered the ward, we have observed no other since.

We have considered carefully the articles in the literature on phosphates and are sure that it is *the* factor in the growth of young bone. We think that some day it may be utilized to activate the growth in adult bone and to aid in healing. The use of calcium salts in the production of a union, given orally, intravenously or injected at the site of the fracture, has not proved to have the least possible value. My associates are convinced that the use of a certain vitamin product, the name of which I do not wish to mention, had a distinct influence upon the production of arteriosclerosis, but the evidence is too uncertain to justify a positive statement. Further investigations will be conducted.

The treatment of non-union by boring holes back and forth through the un-united area receives considerable comment in the literature, one article reporting 19 cases with 19 cures. We believe that this method will be successful in probably 40 per cent of the cases, and then it can be successful only if there is a very close approximation of the fragments and a very small amount of interposition.

CONCLUSIONS

On bone growth the following facts are evident:

1. We believe there is life present in autogenous bone grafts as evidenced by retention of its form, subsequent bleeding and later the reproduction of bone if fractured. This life cannot be demonstrated by the ordinary histological methods but, in our opinion, it will be demonstrated later by new histological methods.

2. Boiled bone, whether autogenous, homogenous, or heterogenous, always remains a sequestrum. Under certain unknown conditions it may be absorbed.

3. Periosteum can and does develop bone, but it can also, under certain conditions, interfere with bone growth.

4. In the adult, bone defects of the tibial border removed for transplant will not be regenerated. Where the cortex has been removed, bone defects are regenerated in a very imperfect manner, many times no regeneration at all occurring.

Non-union most frequently results from the following causes:

1. Excessive force that continues after the fracture has occurred, producing injury to the periosteum, the structures adjacent to the bone, and the blood supply of the bone.

2. Messy manipulation carried out with the hope of ascertaining whether there is or is not a union.

3. Failure of bone to regenerate in certain fractures of the upper end of the tibia with no chance of interposition.

4. Other factors, almost too numerous to mention, have been given as causes of non-union but, in our experience, have had little, if any, significance.

THE STATUS OF FRACTURE TREATMENT IN THE FIELD OF SURGERY[1]

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THE treatment of fractures has advanced by tremendous strides in the last two decades. It has had to do so, first, to cope with the problems arising in and from the Great War, and then to deal with the situation created by the placing of fracture treatment on an economic basis as the result of Workmen's Compensation legislation. It is rather interesting that the astonishing improvement which has taken place has not resulted in the enunciation of a single new principle, but has been the outcome of forced recognition of the significance and implications along pathological and physiological lines of basic principles evolved many years ago. As a natural consequence of this new conception of the meaning of basic principles, there have been developed methods of treatment calculated best to meet the new demand, that of not only making the injured man well, but of doing it in the shortest possible time and at a minimal cost.

When fracture treatment was pushed into the economic field, a new importance was given the subject. Once regarded as the orphan child of surgery, it has now become an object of solicitude. Foster parents clamor for its custody. Today the status of fracture treatment in the field of surgery might well be described by the popular witticism: "All dressed up and no place to go."

The orthopedist is firmly convinced that in him lie the qualities which make for proper guardianship of this heretofore neglected child of surgery. The general surgeon is just as certain that the proper bringing up of the little one is *his* sacred duty. And, as is often the case in matters of dispute, they are both wrong. It is time that a few plain truths are recognized before the child dies of too much misdirected solicitude.

In the first place it is to be kept in mind that the care of the vast majority of fractures will never be in the hands of either surgeon or orthopedist. In the second place, it is a debatable point as to whether the ability to care for static, mechanical, skeletal defects and disease of the skeletal system carries any greater implication of capability in the treatment of fractures than does the ability to treat the interior of the abdomen adequately. Both fields come under the heading of surgery. So does fracture treatment. But the principles involved in the treatment of fractures are just as different from those involved in the care of bone and joint disease as they are from those involved in the care of gall-bladder disease.

Injury has a pathology all its own. It has physiological repercussions peculiar to that pathology. And the adequate care of injury is based on principles founded on adequate understanding of that pathology and its physiological implications. To treat fractures with economic efficiency by present day methods requires that the doctor be a surgeon, that he be an orthopedist, but that he have, in addition, appreciation of the peculiar pathology and pathological physiology that char-

[1]Presented in a Symposium on Fractures, before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

acterizes injury, as opposed to disease and to deformity.

What, specifically, does all this generalization mean? It means that efficiency in fracture treatment demands specialized knowledge and training not denoted by the label "orthopedist" or "general surgeon." It constitutes a field in itself. The term "Traumatic Surgery" has been applied to this field. That the appellation "traumatic" has an ironic justification is due to the fact that the care of injury in the average medical school and hospital is considered merely incidental to either the surgical or the orthopedic service.

What must be done then, that this bewildered child of surgery may find itself?

First, recognize the fact that the general practitioner must handle the majority of fractures. Teach him in medical school and hospital how to handle adequately those which he is capable of handling, and how to recognize those which are beyond his capabilities when he first sees them, not after he has proved his insufficiency. These latter are the cases which require a special knowledge and training for their adequate care, and they all too often get the advantage of it only *after* the results of the lack of it have been thoroughly demonstrated.

Second, recognize that the field of fracture treatment as a special one, requires peculiar knowledge and training in the post-graduate education of internes, residents, and junior staff members. This of necessity means centralization and segregation of cases of injury in hospital wards; it means adequate organization. May I stress that word—"organization." It is of much more importance than the doctor in the care of injury. I say that advisedly. Modern treatment methods make proper organization absolutely essential to success. The best man in the field can get but indifferent results without it. A distinctly average man can get excellent results with the proper organization, if he but understand the principles involved. Economic pressure today demands adequate care of the injured. Time and money are the criteria by which results are evaluated, just as much as appearance and function. The treatment of a certain number of fractures constitutes a special field, requires specialized training, and demands, for success, adequate organization not only in the medical school but in the hospital.

The child doesn't need a guardian or a home. It has grown up and it is building its own place and must continue to do so.

THE TREATMENT OF 278 CONSECUTIVE FRACTURES OF THE FEMUR[1]

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THE treatment of fracture of the femur involves the study of a very important and useful member of the human body. These fractures occur in individuals of all periods and vocations of life. The femur constitutes an integral part of the lower extremity and is designed to bear the weight of the body and to serve as a means of locomotion. Its lateral position, in relationship to the pelvic girdle and spinal vertebræ, necessitates its development as a complex mechanical structure, which is perfectly balanced under normal conditions to perform its specific functions.

The human body normally occupies one of three positions: standing, sitting, or lying. These positions are maintained under normal conditions by a proper balance between the lower extremities, pelvic girdle, and spinal column. This balance may be disturbed both anteroposteriorly and laterally.

Any solution of continuity of the femur, which causes a deviation of the normal alinement or produces any disturbance of the normal relation of the extremities to the trunk, interferes with the function of support, locomotion, and proper balance, and also casts its reflexion upon the function of the spinal cord, chest, abdominal and pelvic viscera. The underlying principles in the treatment of such fractures, should be the restoration of function and equilibrium of the limb when balance has been disturbed.

A careful review and analysis of our own work over a period of many years brings to light the many difficulties encountered in the early days and the institution of better and more modern methods within recent years.

The increasing demand of industry and the intelligent public for better results should keep us mindful of our duty to a problem which we should consider as within the realm of major surgery, but which until within the past few years, has been looked upon lightly by the general surgeon.

Space does not permit a broad discussion of the problem, so that we hope that merely a brief statement of our own experience in the development and progress of our work on fracture of the femur from 1916 to 1935 may be helpful. Throughout this period, we have striven constantly for a more constructive standard of treatment. A careful review of the early literature reveals a high incidence of disability and mortality, a fair proportion of which was directly traceable to the lack of proper first aid, to improper medical service, and to poor transportation facilities.

A great proportion of our series consists of an industrial group of patients, employed in the mines of the Pittsburgh Coal Company, whose activities lay within a short distance from Mercy Hospital, Pittsburgh, Pennsylvania. An organized plan by the employer to improve conditions has occasioned the training of 80 per cent of their employees, who now hold first aid training certificates. First aid stations to the number of 173 have been installed within 21 mines. Each station has complete first aid equipment. The physician's emergency office is conveniently located at the entrance to the mine. The patient is immediately rendered service by his companions with prescribed first aid methods. The strict routine of these methods, when properly instituted, so that the patient may be transported safely to the hospital, reduces the dangers of further destruction of tissue and the development of shock, as has been pointed out in timely fashion by Bancroft.

We have always entertained a feeling that the story of success or failure in the treatment of fracture of the femur, whether it pertains to restoration of function or mortality, is written during the first 48 or 72 hours after injury.

Our preliminary measures are quite conservative and cautious. An immediate survey of the patient is made to reveal the presence or absence of shock, the type and nature of fracture, and the character of his associated injuries. If only moderate shock exists, and the first aid immobilizing splints are secure, he is carefully placed in bed without the removal of his clothing, to minimize further trauma, to avoid further shock and to escape the infrequent but occasional sudden death from fat embolism. Preliminary X-ray films as a rule are portable. When the condition of the patient permits, the limb is carefully cleansed, shaved, and temporarily immobilized by a Buck's extension and is retained in a Thomas splint. Further measures for the control of shock are

[1]Presented in the Symposium on Fractures, before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

instituted; if already present, immediate therapy is established for the prevention of impending intestinal ileus. The frequent occurrence of intestinal ileus has inspired us to anticipate its development and to establish prophylactic treatment. Its insidious onset and progress frequently prove confusing to the inexperienced physician. It is difficult to control and is extremely tragic if permitted to develop to its full state.

Reduction of simple fracture of the femur of all types by the time honored Buck's extension method, protected by coaptation pads, and supported by the Thomas splint, has proved successful in about 10 per cent of our cases. Its application has been quite useful in the aged and young children and in certain badly comminuted fractures of the shaft. Successful reduction of displaced fractures of the shaft by this method alone has been rare. We have been quite cautious in attempting reduction by manual traction and manipulation. The use of local anesthesia about the site of fracture reduces the degree of activity and lessens the danger of fat embolism and further tissue injury. This method with the aid of the fluoroscope, has proved quite useful in the hands of Campbell and others. The method described by Russell in 1924 with Mahorner's recent modification is undoubtedly safe and worthy of much consideration.

The advent of direct skeletal traction offers definite advantages. The Kirschner wire and Steinmann pin, which have supplanted the use of the ice tongs, have been very satisfactory. We have confined their use chiefly to the supracondyloid and comminuted displaced fracture of the lower third of the femur. The insertion of the wire or pins through the supracondylar region at right angles to the axial line of the femur, so that correct apposition of the fragments may be had in both the anteroposterior and lateral positions, is the important factor in its application. To date we have experienced no evidence of infection, necrosis, or osteomyelitis.

Certain of our fractures of the lower third, with posterior displacement of the upper end of the lower fragment, developed evidence of circulatory obstruction of the lower extremity. Traction and manipulation in this instance was associated with great danger to the popliteal vessels. Open reduction in several cases showed sharp bony spicules engaging the outer vascular coats. These were carefully released without damage to the artery, thereby preventing the development of gangrene and subsequent amputation.

During the past 2 years, the application of the Anderson direct skeletal traction splint for reduction of fracture of the neck has proved quite satisfactory. The insertion of the pin into the tibia, as described in the original article, has produced much discomfort about the knee, and following removal of the splint, there was noted some instability of the lateral ligaments. We have found that a more useful and comfortable method can be had by inserting a more stable pin through the condyles of the femur, thereby avoiding traction upon the knee and permitting direct leverage of the lower fragment, which affords better opportunity for good apposition.

However, the ultimate realization of the cardinal principles of good union is, namely, firm approximation of the fragments with permanent fixation. This holds true perhaps more in fracture of the neck than elsewhere in the bony anatomy. Fracture of the neck of the femur still remains, as pointed out by Speed, the unsolved fracture. In view of our unsettled knowledge of the vascular disturbance and the unsolved pathological changes in fracture of the neck, we should follow the precepts of standard methods and produce, if possible, firm apposition and permanent fixed retention. The preliminary application of the Anderson splint to establish length simplifies the procedure of open reduction at a later date. We prefer either the modified bone wire peg of Henderson or the Smith-Petersen flanged nail. The uncertainty of union in fracture of the neck, within a reasonable period of convalescence, has stimulated our interest in the value of a prolonged convalescent period which increases with age. We feel that a complete transformation period of absorption, re-establishment of circulation, and repair should develop before the weight bearing period is definitely established.

Our best results in intertrochanteric fracture have been obtained by the Anderson extension method. The excellent blood supply in this area favors good union when approximation is established.

Fracture of the shaft of the femur constitutes the greatest number of our series. We find a wide range of varieties occurring among all ages, but chiefly during the third and fourth decades, which we believe has cast a favorable influence upon our results.

During our early years, the methods of reduction were few. Amputation, deformities, and disabilities passed along without explanation or apology. The mortality of open reduction occasioned too great apprehension for its general recommendation.

The demand of the times, however, has developed a keen reconstructive interest among sur-

geons, notably the Fracture Committee of the American College of Surgeons, who have accomplished much to standardize the various forms of treatment.

We have endeavored to establish, during the first 2 days, a method which will promote permanent fixation. The early application of well applied adhesive extension with 30 or 40 pounds weight over a pulley, molding by coaptation splints, suspension in a Thomas appliance, are sufficient at times to obtain complete length, good alinement, and approximation in badly comminuted fractures. Extensive comminution, we have found, favors early and rapid development of callus. Not infrequently in this type, we find evidence of interposing fragments which delays or prevents the development of union. The importance of early recognition in such conditions cannot be overemphasized, and early surgical intervention is clearly indicated in order to avoid delayed or non-union.

The extension method with the aid of the Steinmann pin or Kirschner wire has not proved so satisfactory in fractures of the middle or upper third. In supracondylar and displaced fractures of the lower third, our results have been quite gratifying.

The many advances which have developed in the open method of reduction within recent years have established its position among the standard methods. We do not consider this procedure a routine measure but reserve its selection in the treatment of acute fractures, when we fail to accomplish good coaptation and retention by the closed or other conservative methods. The selection of open reduction in acute fractures should be established at a timely period before the regenerative properties of the bony and soft tissues have become exhausted. Delay in open reduction is costly and reflects unfavorably upon the real value of the method.

The uncertainty of the plaster cast as a sole permanent, retentive, and fixative agent in fractures of the shaft precludes its use as a reliable method of treatment.

We have endeavored to perfect a simplified technique for open reduction which will assure an orderly operation with speed and safety. The improvement in our technique has been in the institution of certain important measures: the Hawley table, nitrous oxide oxygen anesthesia with carbon dioxide reventilation, standardization of instruments, and blood pressure observations during the operative procedure.

The advantages of the Hawley extension table in open reduction of the femur are numerous. Following careful adjustment of the patient to the table, the entire field of operation is prepared, before the administration of the anesthetic. Following exposure of the fracture, reduction and correct approximation can be had by gentle mechanical traction, which reduces traumatism of tissues to a minimum.

The selection of the type of anesthesia is of great importance with reference to the various contributory factors in the development of shock. In 103 open reductions, the following types of anesthesia were administered: ether, 23; nitrous oxide oxygen with carbon dioxide combination, 78; spinal, 2. The advent of complete nitrous oxide oxygen anesthesia on our service in 1921 for open reduction of fracture of the femur was an important acquisition in the prevention of shock.

The third factor of importance includes the perfection of a properly systematized technique during the operative period, by which the operator can conduct the procedure without interruption. The selection of a few simple, yet useful instruments, which the operator can handle with ease, has always been our desire. This practice has simplified the difficulties of attempting correct approximation and has permitted the application of the fixative agent with a minimum disturbance to the bony and soft structures. We have confined our fixative agents to bone grafts, wire, and the Sherman vanadium bone plate. In badly comminuted fractures with displacement when open reduction is indicated, the use of wire and plate has been found useful. In non-union the use of a properly secured bone graft has given us almost perfect results. In a majority of cases we have favored the vanadium or alloy bone plate which can be easily fixed, if temporarily secured to the shaft by a Lowman bone clamp. The insertion of the screws can then be performed rapidly by means of a special gauge screw which corresponds exactly to the size of the drill bit. Each screw has been previously attached to a retentive screw driver in order to expedite its application. The soft parts about the site of fracture, including the fragments, are handled carefully and disturbed as little as possible except for the excision of interposing muscle or ligamentous tissue. This is a frequent finding and undoubtedly a factor in the failure of reduction by the closed method. In delayed reduction, one finds a rapid transition of the interposing muscular tissue into dense firm fibrous bands.

Excessive traumatism and disturbance of the early reparative mechanism of the tissues, which is difficult to avoid in open reductions in delayed

TABLE I.—SUMMARY OF 278 CASES

Decade		Month		Year	
Age in years	Cases	Month	Cases	Year	Cases
0– 9	30	January	26	1916	13
10–19	21	February	26	1917	11
20–29	43	March	20	1918	23
30–39	61	April	20	1919	11
40–49	73	May	24	1920	18
50–59	28	June	23	1921	10
60–69	14	July	37	1922	7
70–79	6	August	20	1923	18
Unknown	2	September	21	1924	10
		October	24	1925	9
Total	278	November	16	1926	14
		December	21	1927	24
				1928	21
		Total	278	1929	10
				1930	17
				1931	14
				1932	17
				1933	10
				1934	11
				1935	10
				Total	278

cases, have been attended by certain delays in the formation of callus development.

Rather than prolong the operative period by the application of plaster, we have found sufficient protection by the use of the Thomas splint. The lower leg is fixed below by an already applied adhesive extension, and coaptation splints are applied to the thigh for additional protection.

The fourth factor mentioned, namely, blood pressure observations during the operation, has been found of great value as an index for the early detection of shock. Observations are taken immediately before and throughout the operation every 2 to 4 minutes. These observations show the usual high systolic rise during the preliminary stages of the anesthesia. Certain activities at the site of fracture occasioned by extension of the limb, manipulation of the fragments, curettement or chiselling of old callus, drilling of the bone, insertion of the screws, will influence the vasomotor mechanism according to the degree of activity. This reaction will immediately record a fall, first, of the systolic and later the diastolic pressure. These important observations denoting the presence of shock, even before the physical appearance of it is apparent, have been found consistent in many cases. The operative activities cease at this point until the patient has convalesced from shock. Recovery may require several days before reduction can be completed with safety.

These factors, particularly the latter one, have not only afforded opportunities for better results but have favorably influenced our mortality rate in open reduction.

In our series of 278 cases, 15 fractures were found to be compound. The percentage is quite low as compared with fractures of the tibia, fibula, and upper extremities. As a rule there is no great destruction of soft tissue as frequently found in the tibia, unless the injury has been of a direct massive character. A number were small puncture wounds which developed from within out and which always lessen the possibility of internal contamination. In the more extensive type with destruction of the soft parts and exposure of the fragments, we favor immediate open reduction, provided the condition of the patient permits. For many years we have practiced immediate permanent fixation of the fragments, sensible débridement and open exposure of the wound by the application of a self-retaining retractor; rubber tube drainage is inserted between the separated muscle bundles followed by the application of a loose gauze pack for the wound. An abundance of gauze is applied to the entire limb and it remains *statu quo* for a period of 2 to 4 weeks.

During this period the temperature subsides, the local reaction recedes, and there is a profuse foul smelling discharge, but much to one's surprise a healthy granulating wound is observed upon the first dressing, even though a culture of the discharge may show several varieties of pathogenic organisms. The care of the wound continues in this manner with infrequent dressings and its reparative nature progresses without active infection or any interference of callus formation. This method is in many respects similar to the procedure advocated by Orr and has been a method of procedure in many of our compound fractures since 1916. In selective cases chlorinization of the wound proved of value; in certain others, larval therapy was efficacious.

SUMMARY OF CASES

A brief summary of our cases including fractures of the entire shaft of the femur presents many interesting phases. Since 1916 we have treated 278 consecutive cases of which 144 occurred in the third and fourth decades of life.

We find a definite seasonal variation of occurrence of coal mine accidents, showing an increase during the warm months. In our series the majority occurred during the month of July.

It is of interest to note the various types of fracture as to location, resulting chiefly by direct violence, from falls of coal, slate, and posts. Fractures of the shaft with the middle third predominating occurred most frequently, 191; followed by fractures of the neck, 42; intertrochanteric, 11; supracondylar, 10; intra-articular, involving the knee, 7; double fractures, 7; exact site of shaft unknown, as result of early death without X-ray study, 10.

TABLE II.—TYPES OF FRACTURE AS TO LOCATION

Site of fracture	Cases
Fracture of neck	42
Intertrochanteric	11
Shaft—Upper third	51
Middle third	99
Lower third	41
Supracondylar	10
Intra-articular of knee	7
Double fractures	7
Location unknown	10
Total	278

TABLE III.—SUMMARY OF AVERAGE X-RAY SERIES PER CAPITA

Non-operative cases	Total X-rays	Average per patient
1916–1925	147	1.9
1925–1935	296	4.1
Operative cases		
1916–1926	136	3.5
1925–1935	258	4.4

TABLE IV.—CAUSES OF POSTOPERATIVE DEATHS

	Cases
Shock, embolic	3
Septicemia	2
Total	5

An attempt to standardize the average number of X-ray series including all views for a complete study throughout the entire period of treatment, is rather difficult; however, the records shown in Table III afford a fairly accurate average by excluding 20 X-rays in certain deaths which occurred shortly after admission.

The selection of the fixative agent, we find, depends upon the character and location of the fracture. For many years we have favored the Sherman vanadium bone plate. Its application to the femur represents a high percentage of unabsorbable foreign substance and interferes in certain cases with the local formation of callus. The simplicity of application and the firmness and security of apposition when correctly inserted have outbalanced certain criticisms which have been offered against its use. In our series of 103 open reductions, 82 bone plates have been used. In 9 cases, or 11.1 per cent, their removal was indicated for various reasons. Other types of internal fixative agents were used when especially indicated. In the series reported, the following fixatives were employed: bone graft, 3; wire, 11; nail, 5; screws, 1, and no retentive appliance, 3.

Cases of delayed and non-union were 3 and 5, respectively, in the entire series of 278 cases.

The presence of local wound infection in our series of 103 operative cases fortunately was low. Five wounds were involved, 2 of which developed septicemia resulting in death. The 3 remaining were entirely local, 1 of which definitely delayed union.

A summary of our mortality tables (Table V) has proved very interesting and undoubtedly will be of great assistance in our future work. In a total of 278 cases there were 32 deaths, or 11.5 per cent. Included in this series are many patients who died a few hours following admission to the hospital.

Our records indicate that 21 died within 5 days after admission, 18 within 2 days, 13 within 24 hours, 9 within 8 hours, and 7 within 5 hours after admission. A considerable number of these patients had sustained severe associated injuries, which not only delayed the employment of adequate local surgical measures but were direct contributors to the cause of death.

The non-operative cases total 175 with a mortality of 27 or 15.4 per cent. This rather high percentage was influenced, as noted, by the great number who died shortly following admission.

The operative cases, which total 103, showed a death rate of 4.5 per cent. Included in this group are 2 cases of fracture of the shaft; 2 confined to the neck; and 1 of both neck and shaft on opposite limbs. The cause of death in 3 was attributed to postoperative shock of an embolic type; the remaining 2 developed septicemia some time following the operation from wound infection.

The general causes of death, as found in Table VI, show that shock of various types and toxemias as the result of acute infections, are the major factors. Other causes as noted, namely, coronary occlusion, circulatory failure, uremia, and pulmonary embolism occur infrequently.

The primary desire of every surgeon undoubtedly is to save the life of his patient. Second in importance is the rehabilitation of the injured individual, so that he may again assume his productive position in society at an early date. The hospital service extended to our patients by the employer includes, in addition to the treatment of their acute illnesses, complete physiotherapy which not only hastens their return of function but is decidedly beneficial to their employer.

A review of our series with reference to hospital confinement and total convalescence shows an average of 110.2 days and 252.3 days, respectively. The average hospital confinement of closed reduction was 95.6 days; for total convalescence was 213.7 days. The average hospital confine-

TABLE V.—SUMMARY

No. and time in hospital	Type of fracture	Associated injuries	Complications	Cause of death	Operated upon
1. 25 hrs.	Simple-neck	Fracture pelvis, chest, humerus	Trauma, shock, ileus	Traumatic shock	No
2. 5 da.	Simple comminuted middle 1/3	Fracture scapula	Lobar pneumonia	Lobar pneumonia	No
3. 3 min.	Simple comminuted middle 1/3	Fracture skull, jaw, ribs, nose	Shock, hemorrhage	Shock, hemorrhage	No
4. 5 min.	Compound lower 1/3	Fracture dislocation hip; fracture vertebræ	Shock	Traumatic shock	No
5. 32 hrs.	Simple lower 1/3	Traumatic amputation foot, compound fracture tibia-knee joint	Shock, hemorrhage	Shock, hemorrhage	No
6. *5 da.	Old ununited upper 1/3		Shock, post-operative	Shock, embolic	Yes
7. 2 hrs.	Compound comminuted lower 1/3		Shock, hemorrhage	Shock, hemorrhage	No
8. 79 da.	Simple comminuted middle 1/3		Pneumonia	Influenzal pneumonia	No
9. 64 da.	Simple-neck	Fracture scapula, ribs, pelvis, vertebræ, shoulder	Pneumonia	Influenzal pneumonia	No
10. 9 da.	Simple comminuted upper 1/3	Contusion back, laceration scalp	Shock, ileus, pneumonia	Hypostatic pneumonia	No
11. *25 da.	Simple comminuted middle 1/3 Simple-neck	Laceration scalp and cheek	Infection wound, septicemia	Septic pneumonia, septicemia	Yes
12. 4 hrs.	Compound comminuted lower 1/3		Gas bacillus, shock	Toxemia, acute shock	No
13. 5 hrs.	Compound lower 1/3	Compound humerus, dislocation hip, fracture ankle	Shock, ileus	Traumatic shock	No
14. *5 da.	Simple middle 1/3		Shock, embolism—Cardiac and pulmonary	Shock, embolic	Yes
15. 2 hrs.	Simple middle 1/3 Simple lower 1/3	Fracture skull, laceration wrist	Traumatic shock, ileus	Traumatic shock	No
16. 2 da.	Simple middle 1/3	Fracture skull, nose, orbit, jaw	Cerebral compression	Shock, cerebral compression	No
17. 7 hrs.	Simple-neck	Fracture pelvis, clavicle	Shock, embolism—Cardiac and pulmonary	Shock, embolism	No
18. 53 da.	Simple comminuted upper 1/3	Laceration scalp, shoulder, ankle		Coronary occlusion	No
19. *28 da.	Simple upper 1/3	Fracture vertebra, tibia, ankle	Septicemia	Septicemia	Yes
20. 31 da.	Simple intertrochanteric	Laceration arm and orbit		Embolism—pulmonary	No
21. 1 da.	Simple middle 1/3	Fracture pelvis, chest, clavicle	Shock, ileus	Traumatic shock	No
22. 55 da.	Simple-neck	Crush of chest	Carbuncle, Parkinson's disease	Circulatory failure	No
23. 6 hrs.	Simple middle 1/3	Fracture pelvis, vertebra, liver	Hemorrhage	Shock, hemorrhage	No
24. 34 da.	Simple upper 1/3		Cardiorenal failure	Uremia	No
25. 3 hrs.	Simple lower 1/3 R-L	Compound crush tibia	Shock, hemorrhage	Shock, hemorrhage	No
26. 1 da.	Simple middle 1/3	Fracture humeri, internal injury	Shock, embolism	Shock, embolism	No
27. 2 da.	Compound middle 1/3 L Compound upper 1/3 R	Fracture wrists, crush of chest, rupture intestine	Hemorrhage Peritonitis	Peritonitis, toxemia Shock	No No
28. †62 da.	Simple-neck		Shock, embolism—pulmonary	Shock, embolism	Yes
29. 8 hrs.	Compound middle 1/3	Crush chest, vertebra, abdomen	Shock	Shock, embolism—pulmonary and cardiac	No
30. 1 da.	Compound lower 1/3	Crush vertebra, abdomen, shoulder	Shock, embolism—pulmonary and cardiac	Shock, embolism—pulmonary and cardiac	No
31. 22 da.	Compound lower 1/3		Acute alcoholic, ileus	Circulatory failure	No
32. 2 da.	Simple lower 1/3		Acute alcoholic, ileus Pneumonia	Influenzal pneumonia	No

*Before operation, 5 days.
†Before operation, 61 days.

Summary	Cases	Per cent
Total fractures of femur	278	
Deaths	32	11.5
Non-operative cases	175	
Deaths	27	15.4
Operative cases	103	
Deaths	5	4.5

TABLE VI.—SUMMARY OF THE CAUSE OF 32 DEATHS

	Cases
Shock	
Traumatic	5
Hemorrhage	5
Embolic	7
Cerebral compression	1
Toxemia	
Lobar pneumonia	1
Influenzal pneumonia	3
Hypostatic pneumonia	1
Septicemia	2
Gas bacillus	1
Peritonitis	1
Other causes	
Coronary occlusion	1
Circulatory failure	2
Uremia	1
Pulmonary embolism	1

TABLE VII.—AVERAGE HOSPITALIZATION AND CONVALESCENT PERIODS IN DAYS, 278 CASES

	Average days
Average hospital days	110.2
Average hospital days of closed reduction	95.6
Average hospital days of open reduction	134.8
Average convalescence	252.3
Average convalescence of closed reduction	213.7
Average convalescence of open reduction	266.6

ment for open reduction was 134.8 days; total convalescence for open reduction was 266.6 days.

The evident disparity noted in the cases without operation as compared with the ones with, is to be explained by the fact that the group treated by closed reduction includes not only those patients who died shortly following admission but also those with the less grossly displaced fractures of the femur.

We have endeavored in this discussion to indicate the interesting factors in the progress of our work with the hope that it may contribute something of value in the standardization of treatment.

In conclusion, it has been the authors' hope and intent to present an impartial review of 278 fractures of the femur. The methods of therapy have at all times been held flexible. Improvements in technique have been accepted and utilized in every instance when found applicable to the given case and within the scope of our talents. At no time has stereotyped procedure been employed or advised; rather, it would seem to be the dictum of experience to allow each case to warrant the particular measure of care it may best accept.

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FENDER FRACTURES[1]

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THE so called fender fracture is a comminuted compression fracture of the outer tuberosity of the tibia produced by a force exerted from the outer side which causes valgus strain.

In an accident of the sort here concerned the luckless pedestrian, standing with his leg straight in the moment of stress, is struck from the outer side by fender, mudguard, or tire. The blow is received at or below the knee and forces the leg into valgus position, that is a knock-knee position. Something must give way. The lower end of the femur as a whole may break, the internal condyle may be torn loose, or the internal lateral ligament may be torn. But in practice and in fact usually it is found that the external condyle of the femur is driven down and so crushes and displaces the outer side of the tibia outward and downward. As a rule the break is such that the articular seat of the fibula, and with it the fibular head, moves outward and down with the fragments of the shattered tibia. Uncommonly the fibula is broken also. The details vary. Sometimes there is, or seems to be, a single large fragment of tibia displaced *en masse*. Oftener there is much and obvious comminution which extends to or through the joint cartilage.

Often the comminution is much more extensive than the X-ray film indicates, and, on account of the comminution and the consequent impossibility of satisfactory reduction and maintenance, I think it is fair to say that those who have seen many of these cases have come to regard open operation as not the method of choice but rather one to be avoided.

The essential feature of this injury is the crushing down of the weight bearing surface of the tibia on the outer side. This fact alone justifies its classification as a separate entity.

The problem is to restore this weight bearing area to mechanical function as best we can. In this task the handicaps are the muscle pull of the outer hamstrings, and later, the stress of weight bearing. In many cases, however, not all of the tuberosity is crushed; usually the back half is the part most seriously affected. Even with the best X-ray films it is difficult to determine the precise amount of injury; probably because part of the surface is intact. It is for this reason, perhaps, that the clinical results in these fractures, when recognized and treated, are amazingly better than would be expected; conversely, the results in such fractures when not recognized or when treatment is bungled are amazingly bad, incredibly bad, for the patient may be left with extreme knock-knee and a loose, useless joint.

Clinical examination reveals an obvious genu valgum of varying degree with more or less outward lateral mobility, and unless studied further the fracture is often overlooked. The X-ray film shows a picture which is not unusual: It is noted that the fracture is a ragged one as a rule, with a crushing down of the outer side of the tibia which has been driven down by the impact of the more solid outer femoral condyle. The tibial fragment, or oftener fragments, are driven outward and downward, thus giving place to the outer condyle of the femur. Usually the upper end of the fibula is displaced outward also.

It is evident that there are two sorts of injury: In one, one main fragment seems to be driven outward, a picture that tempts the surgeon to do an open operation. It is true, however, that replacement of such a fragment is done far better by impaction from without, since the spiking or screwing fast of the fragment is difficult because the bone is friable and therefore not strong enough to hold screws. In the other type of fracture, the comminuted type, it is obvious that any fixation after the joint is opened is impossible.

The argument that one should do an open operation because there is a probability of later trouble with the semilunar cartilage seems a poor one to me. I have heard of later displacements of the cartilage, but in a large series of cases I have seen no such trouble. As to removal of the cartilage, it seems clear that if ever the cartilage is needed it is in these cases to maintain an articular surface and with its actual bulk to fill space. So that I am entirely against open operation, and although I have done it often, I shall probably never do it again. Better reductions with more prompt healing and better final results can be obtained without open operation.

The problem of caring for fender fractures is really a rather simple one. First, with patient under anesthesia, a space on the outer side of the joint is opened up by bringing the leg into overcorrection, which means it is placed in as near a bow-leg position as can be contrived with reasonable force. Next the displaced fragments are pushed as nearly as possible into their normal positions. This maneuver involves pushing the

[1] Presented in the Symposium on Fractures, before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

fibula inward as well. Much can be done with strong thumbs. Some surgeons use screw pressure with a furniture clamp or its equivalent. Personally if thumbs seem inadequate, I am apt to use a hammer. The knee is protected with a felt pad, and the blow or blows are delivered close to the joint over the broken condyle and the upper front of the fibular head. In this way any possible damage to the external popliteal nerve, in its curve about the fibular neck, is avoided. The method works and has the advantage that the force of the blow may be delivered upward as well as inward, which is what is wanted. There has been no case of local damage as the result of the pounding, and the reduction of the fragments seems to be as accurate if not more accurate than that produced by any other method. Perfect restitution is, of course, never attained, but adequate repair and function do not seem to require it.

The next problem is the maintenance of reduction. It must be remembered that an instant's relaxation in the correction of the leg as a whole means disaster and the reproduction of the original deformity by muscle pull. Therefore, a close fitting plaster cast is essential. The cast is molded to give pressure outward on the inner side of the knee and inward on the lower part of the lower leg. In addition moderate pressure over the broken condyle probably helps. After 3 weeks, gentle motion is begun but with the leg supported or hanging straight. After a month, a caliper splint which gives support by padded plates at the indicated points may be worn by day and the plaster cast at night. After the lapse of 5 or 6 weeks, weight bearing with the splint is permitted. Unsupported weight bearing should not be allowed earlier than 12 or 14 weeks after the injury. The end-results depend mainly on the thoroughness of treatment. With the treatment just outlined, there should be no unstable joints.

Motion of the joint to a right angle or better may be counted on, the mobility varying from that point to an absolutely normal motion. Broadly speaking, however, some loss of knee flexion results, but stable, strong, painless joints are secured. If fractures of this type are not reduced or are poorly reduced there result a conspicuous genu valgum and some, often great, lateral instability, which necessitate such relief as can be obtained by supracondylar osteotomy and correction of the weight bearing line.

In conclusion I would make a plea for the careful study of fender fractures so common in these days of auto traffic injuries so that they may be recognized and treated as a real fracture entity. This injury, so often underestimated as to its seriousness, needs and greatly merits real study and most thoroughgoing care.

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LOCAL ANESTHESIA IN FRACTURES[1]

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DURING the past 15 years, ending December 31, 1934, we have treated at our private clinic 5,910 fractures. The diagnosis of every fracture was confirmed by an X-ray film and a complete record and follow up has been made of every fracture.

As a pupil and for many years an enthusiastic admirer of the monumental Rudolph Matas, of New Orleans, I necessarily have been keenly interested all my professional life in local, infiltration, and regional anesthesia. Even as a student in dear old Charity Hospital in New Orleans, I was amazed and thrilled to see Professor Matas resect the superior and inferior maxilla under local and regional anesthesia, amputate arms and legs, and resect joints. Thus, I have always set fractures and reduced dislocations of phalanges and metacarpal and metatarsal bones under infiltration and regional anesthesia. Also, in open operations for reduction of fracture of the radius and ulna, tibia and fibula, and fractured patella, in 75 per cent of the cases operations have been done under local and regional anesthesia. In operations on the skull for depressed fractures, for compound fracture of the skull, for extradural and subdural hemorrhage, we have preferably used for many years, infiltration anesthesia.

However, it was not until the fall of 1927, while watching the practical, ingenious Lorenz Boehler, in his clinic in Vienna, inject a 2 per cent novocain solution between the ends of the broken bone and secure, in a few minutes, perfect analgesia and perfect muscle relaxation, that lasted usually from 1 to 1½ hours, that I realized what a marvelous adjunct to the treatment of fractures we had in local anesthesia. I was not impressed, however, with nor have I been enthusiastic about, the use of regional anesthesia for setting fractures of long bones and for reducing dislocations of large joints as practiced in Boehler's clinic. I believe that ether anesthesia is more practical and safer in the majority of such cases.

Every doctor who treats or may treat fractured bones should familiarize himself with the simple and safe method of producing complete analgesia at the site of fracture and complete muscular relaxation, by injecting from 5 to 50 cubic centimeters of 2 per cent sterile novocain in normal saline solution directly into the hematoma or blood pool between the ends of the broken bone or bones. If the hematoma is present and the 2 per cent novocain solution has been injected into the blood pool, complete analgesia will occur in about 10 minutes and will last from 1 to 1½ hours. If there is no definite hematoma because the fracture is of the impacted or greenstick variety, then it will be necessary to inject the solution into the muscular tissue adjoining the fractured ends and also under the periosteum to get analgesia and relaxation; in other words, to use infiltration anesthesia.

Anesthesia used. In our clinic we have used 2 per cent solution of novocain in normal saline. The amount varies from 5 to 50 cubic centimeters, but after injecting 25 cubic centimeters we watch the patient carefully for toxic symptoms. We have never had a death from novocain poisoning, but we do occasionally get toxic symptoms in infiltration anesthesia when using more than 10 cubic centimeters of 2 per cent novocain solution, so this strength solution must not be considered entirely harmless.

Technique of injection and paraphernalia necessary. The instruments and materials needed are: one 10 cubic centimeter glass syringe, 1 fine needle and 1 long medium shaft needle, 1 hemostatic forceps, 2 per cent novocain solution in normal saline, ether and iodine, cotton applicator and gauze.

The operation must be carried out with most meticulous regard for surgical asepsis—and this precaution is so easily, quickly and economically taken care of with the simple equipment just named. An outfit of this description should be carried as a sterile fracture package in the surgical kit of every doctor who does, or may do, fracture work. In our clinic all fractures are treated as an immediate emergency whether the patient is admitted during the day or at night. An X-ray picture is made at once. If in our judgment the fracture should be reduced under local anesthesia, if it is a simple fracture, the site of the fracture or fractures is noted on the X-ray film and then verified by palpation with the finger. The area is cleansed with ether and a small area is painted with iodine; at this site a wheal is made with the fine needle, a forceps, of course, being used to apply the needle to the syringe, and the soft tissues to the bone are injected slowly and gently so as to avoid pain. The long needle is then attached and an attempt is made to locate the hematoma surrounding the ends of the broken

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bone or bones. When the hematoma is found, by slight suction or without suction, a light colored fluid is aspirated into the syringe, then the 2 per cent novocain solution is slowly injected into the blood pool. If the blood is from a vein it will be much darker than the fluid from the hematoma. Injection is continued without withdrawal of the needle until there is analgesia and complete muscular relaxation, or marked tension of the tissues from the infiltrating solution. When the needle is withdrawn, the opening is sealed with gauze and kept sealed until the fracture has been reduced.

Many years ago, a dentist gave me an inspiration about local anesthesia. He had the reputation of doing dental work without pain. I called to see him and noted that after making his anesthetic injection, he left this patient to work on another patient, thus giving the anesthetic time to deaden the tissues. Reduction should not be attempted under 10 minutes, and often the analgesia and relaxation is not complete until 30 minutes have elapsed. Relaxation and analgesia thus secured will last from 1 hour to 1½ hours. The more one uses this method, the more enthusiastic he will become, as there is so little pain and discomfort, such perfect relaxation of muscles, and usually such ease of reduction.

Indication. Local anesthesia can be used in all fractures, even compound, except fractures of the spine and the pelvis. Age is no contra-indication.

Advantages. An assistant is not necessary and, in isolated areas, the patient is saved much suffering and long waiting until an assistant can be called to give a general anesthetic. It allows for repeated manipulation without the necessity for a second anesthesia or a long continued anesthesia. If the fracture is associated with brain trauma, as so many of the fractures due to automobile accidents are, and a general anesthetic cannot be given, local anesthesia must be used. Too, when there is profound shock, general anesthesia cannot be used, but local anesthesia can often be used and will actually lessen shock by relieving the pain of the jagged end of bones mutilating the soft parts. Most patients are profoundly grateful for the local anesthesia and will co-operate fully and helpfully as so many have a horror of being put to sleep.

In our clinic every fracture is treated as an individual case and not by any set rule, formula, or standard. We study the fracture on the X-ray film; we study the patient, the surroundings, and then we decide whether we shall use local anesthesia, nitrous oxide gas and oxygen, or ether anesthesia. We are profoundly impressed with the marvelously safe and simple method of reducing fractures by injecting a 2 per cent novocain solution into the hematoma surrounding the broken ends of bones, but we are still using nitrous oxide gas and oxygen and ether anesthesia for reduction of fractures. We will continue to use that method of anesthesia which seems best adapted to the particular patient, time, and conditions present.

AIRWAY AND HIGHWAY FIRST AID STATIONS[1]

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SINCE July, 1931, I have laid my plans before many agencies for the establishment of first aid stations in the United States. In 1933 I interested the American Red Cross in the setting up of first aid stations on the highways. At that time they endeavored to sponsor the movement. Unfortunately, the general financial stringency prevented their backing the movement to any great extent.

Today the American Red Cross is willing and anxious to establish first aid stations on both the highways and the airways of our country. The officials at National Headquarters have just recently approved plans looking to the immediate establishment of first aid stations along our main traveled roads and at emergency landing fields and air ports. There are already 17 first aid and life saving field representatives of the Red Cross devoting their entire time to this work, and 135 first aid stations are now operating in the United States. Definite arrangements have been made to open 432 additional stations within the next few weeks. Conservative estimate indicates that 1000 stations will be arranged for before July 1, 1936.

We in the United States are not alone in recognizing this need. For over a year Canada has maintained first aid posts between Toronto and Montreal. In the summer of 1934 more than 200 automobile injury cases were given first aid care by post attendants. The Belgian, French, and German Red Cross societies are actively supporting this same service on their highways. France, for example, has 2000 first aid stations operating successfully along the highways. The movement has been met everywhere with public approval and praise, and the League of Red Cross Societies has appointed a permanent committee to consider this subject throughout the world.

At the present time we are not prepared to take care of injured travelers; and with an increasing toll of accidents, we find before us a humanitarian duty that is at once neglected and urgent. Since the state and federal agencies have failed to provide means of giving first aid treatment to these injured travelers, it is apparently up to us—up to such a group as the Fellows of the American College of Surgeons—to stimulate the establishing of first aid stations where they are needed; to co-operate with the American Red Cross in seeing that these stations are equipped, and are properly maintained and operated. Since fractures occur in most accidents, the Regional Fracture Committee should be especially interested. Even with the American Red Cross and the American College of Surgeons united in this work, it still cannot succeed unless we have community interest. Co-operation must be obtained from local medical societies, state highway patrols, automobile clubs, chambers of commerce, Boy Scouts of America, telephone companies, service and luncheon clubs, women's clubs, and in particular county officials.

Today we are spending millions in improving our highways and more millions in buying machines with greater speed and power. It is a deadly combination. During the year 1934 there were 35,769 automobile deaths, a 15 per cent gain over 1933. A million and a quarter people were injured in automobile accidents alone. Many of these accidents occur in remote and lonely places where there are no physicians, where there are no facilities for taking care of the injured. Consequently, before trained assistance can be secured, prolonged suffering is bound to occur, to say nothing of the complications and sequelæ which retard recovery, and of the deformities which not infrequently occur. In addition there is the ever present possibility of delay proving fatal to the injured person.

Preparedness, of course, is our first aim. Only then, when an airway or highway disaster occurs, can adequate emergency first aid be given to the injured person without delay. And it is possible to give a very effectual first aid service through the establishment of these first aid stations, and through the training of the people in charge in first aid and fixed traction method of transportation of the injured.

The airway first aid stations should be established at the emergency landing fields as well as at established ports, as it is here that accidents are most apt to occur. At the regular landing fields, these stations will take care of such accidents as occur locally as well as of any injured passengers brought to the fields. Highway first aid stations will be established at remote places where medical care is not available, at important crossroads or other points where accidents are apt to occur frequently, and at convenient intervals along important roads in order to establish a continuous service on all through highways.

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Fortunately, filling stations are usually found at or near these sites and are operated by a good class of people; consequently they can usually be selected as highway first aid stations of the American Red Cross. Wayside stores, residences, and farmhouses also can be designated as stations when it is deemed advisable. The state highway patrol is in possession of valuable data that will be of use in the selection of sites on the highways. A system of mobile first aid stations should likewise be placed in the public utility companies' trucks, and in other vehicles that ply regularly up and down the highways. Trucks thus equipped will greatly expedite this service.

The second consideration in the selection of the station is the ability and willingness of the proprietor and his helpers to give an effectual first aid service. The permanency of the personnel of the stations is a third point to be taken in mind before deciding upon the site.

By way of equipment, each station must keep on hand a sufficient quantity of first aid supplies such as is contained in the Red Cross kits: a blanket, wooden splints, a Thomas-Murray upper extremity splint, a Keller-Blake lower extremity splint, and a stretcher. There should also be two or more persons trained in administering first aid to the injured and fixed traction method of transportation available at all times at each station. Day and night service should be operative. If certain stations remain open only during the day, then they should display a sign giving the location of the nearest full time station.

Care must be exercised in the selection and training of the first aiders. They must not only be taught the administering of first aid but also their relationship to the injured person and to the physician who is to have charge of the case. They must understand that first aid service is strictly an emergency measure, carried out after an accident in the absence of a physician, and that it is preparatory to medical care which must be given as soon as possible. Only emergency first aid service required at the time of the accident is of course permissible, and all injured persons given first aid care must be seen by a physician.

The First Aid Committee of the American Red Cross and the Regional Committee of the College should co-operate, and train those selected to serve at these stations. An adequate training would be that provided in the American Red Cross regulations for first aid course of 15 hours of instruction, or its equivalent. In addition and of equal importance, there should be given a thorough instruction in fixed traction method of transportation for fractures, which is applied before the injured person is moved. We should consider fractures as emergencies and the initial treatment as the most important. Residents in the vicinity of the station then should be trained so that they can assist or act as principals in case of an emergency. No charges are to be made for first aid service or supplies, and no gratuities allowed.

A special accident report form has been prepared by the Red Cross, and a supply of these will be kept at each station to be filled out by the operator, giving an account of each person injured. The stations should also be provided with a telephone, if possible, and either a medical directory or a list of the names of the nearest physicians and approved hospitals. A sign lettered on both sides will occupy a prominent place designating each Red Cross first aid station. Road markers indicating the location of the station will be placed a half mile away on each road leading to the station. An organized volunteer automobile transportation service, if needed, should be established at or near each station, so that the injured may be transported to a physician's office or hospital. Ambulances, passenger cars, and small trucks may be made available for this. Again there will be no charge for the volunteer transportation of the injured; ambulance service, however, when necessary will be paid for by the injured.

The approximate cost of equipping a station is about $30.00. The cost of the articles needed should be apportioned about as follows: twenty-four unit Red Cross first aid kit, $6.25; Thomas-Murray splint, $1.25; Keller-Blake splint, $2.25; blanket, $5.00; stretcher, $6.00; station sign, $4.50; and two to four road markers, $2.25 each. Four road markers of course will be needed if the station is located at an important crossroad. Wooden splints can be made locally under the direction of the first aid committee member, and the annual upkeep should not exceed $10.00. There is no personnel cost in connection with this work as the entire service is on a volunteer basis, from the time that first aid is given until the injured person is delivered to a physician or a hospital. Then and there the free service ends, and it will be expected that direct payment will be made to the physician and hospital for their services. The cost of operating this service then will be slight and can be easily financed from the proceeds of the annual Red Cross roll call with such financial assistance as can be secured from other sources. A plan now being worked out, if successful, would furnish the money for extending a network of stations over the entire country.

The Chapter Executive Committee should take general responsibility and action upon the establishment of the first aid station. The direction of these stations should be given to the First Aid Committee. One member of the committee should be placed in charge of each station and made responsible for its operation. He in turn would co-operate with a member of the Regional Committee or a subcommittee member. Between them they would inspect each station at least once a month to see if the first aiders are maintaining an efficient service and keeping the first aid equipment in proper condition. At the same time they could arrange for the replacement of used materials and collect the accident reports for the Chapter Executive Committee. They would likewise check up on the volunteer transportation service, give instructions as to the disposition of the injured, and follow up accident cases to see that they have received proper care.

The state highway patrol also should be trained in first aid and fixed traction method of transportation by members of the First Aid Committee and Regional Committee. They should carry cards showing their capability to render first aid to the injured, a Red Cross kit, wooden splints, a Thomas-Murray splint, and a Keller-Blake splint. They should frequently contact the first aid stations on their patrol. A display of interest in each station, its service, and the personnel's ability to use their equipment intelligently will do much toward helping maintain vigilant preparedness.

Accidents resulting in bruises, cuts and sprains can be given first aid easily. In case of fractures extreme care must be exercised in the first handling to avoid further injury to the bone and soft structure. Between one and one and a half million fractures occur in the United States each year, and many of them occur on the airways and highways. The medical profession must realize the need of, and carry into effect more generally, the fixed traction method of transportation of fractures. Every doctor should be well trained in first aid and fixed traction so he can instruct the public in these methods and actively assist in carrying on this movement. The fixed traction method of transportation of the injured can be carried out very satisfactorily by a lay person after a short training and with the proper splint, thereby insuring protection to the fractured part and a reduction in the time of recovery. The Boy Scouts of America, the personnel of our regular army, and first aid crews in factories and mines are usually so trained.

Since most of the airway and highway first aid in remote places is given by the laymen, they must be properly prepared to handle these cases when called upon to do so. The manner in which the injured person is splinted and transported is of first importance. Many a simple fracture has been converted into a compound fracture with severe damage done to the soft structure through improper first aid attention. On the other hand, it is estimated that there is an average saving of one hundred dollars in the treatment of each extremity fracture in which the fixed traction method is used. Were this method universal it would result in a saving of approximately thirty million dollars a year to the country as a whole.

When the stations are established, the chapter should announce through the newspapers that this activity is operative in that community. The article should then tell of the nature and the purpose of the service and the location of the stations. I am sure with the whole hearted co-operation of the American Red Cross, the American College of Surgeons, and the laity, a network of first aid stations can be spread across the entire United States within a very few years at the most, stations equipped and qualified to give an efficient service to the injured travelers on the airways and on the highways. And when this is accomplished, it is not beyond the bounds of possibility that the mere presence of these stations will check our mounting toll of accidents. Certainly such stations will be an ever present warning to careless drivers.

CONFERENCE ON TRAUMATIC SURGERY

THE IMMEDIATE AND DELAYED TENDON REPAIR[1]

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THE intelligent surgical repair of injured tendons is dependent upon a knowledge of the anatomical and physiological characteristics of this tissue. This knowledge has developed as the result of the patient labors of many men[2] to whom we must acknowledge our great indebtedness. The time at our disposal does not permit an extended discussion of the general development and extensive literature on the subject of tendon surgery. We have gone into this on two previous occasions. The papers of Sterling Bunnell, of San Francisco, have done so much to fashion our ideas of tendon repair both in this country and abroad, that they must be read by anyone who attempts to do this type of surgery.

Tendon consists of long parallel strands of strong collagenous tissue, insecurely bound together by a sheath which sends into it fine septa dividing it into a number of separate bundles. This binding tissue offers little resistance to separation and fraying of the fibers and makes poor anchorage for suture material. The handling of tendons and the introduction of sutures into them require a careful and special technique, fine instruments, fine needles and thin strong sutures, and a method of suturing which secures a strong hold without disrupting the tendon, damaging its blood supply, or interfering with end-to-end union.

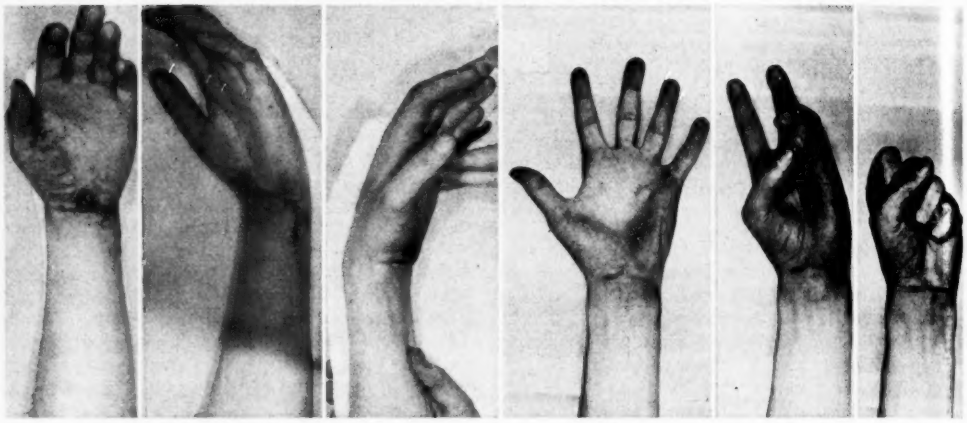
Although poorly vascularized, the tendon receives its blood supply from three sources: from the muscle proximally, from the periosteal insertion distally, and from tissues surrounding it along its course. Tendons without synovial sheaths are surrounded by a specialized type of loose vascular areolar tissue, the paratenon, from which numerous blood vessels enter around the whole periphery. Such tendons are relatively well supplied with blood, are relatively resistant to infection, and tend to heal relatively rapidly, although often in a lengthened condition if a reasonable approximation is obtained, and may even heal spontaneously if merely immobilized. The sheath-enclosed tendons lie suspended in a synovial lined tube by a thin mesotenon through which a rather meager blood supply reaches them. If the mesotenon is injured or destroyed, serious nutritional disturbances ensue; the tendon succumbs easily to infection and reparative processes are seriously retarded or even suppressed. These tendons heal slowly, even under ideal conditions, and their surgical repair should be undertaken only when asepsis is assured and adequate facilities are available.

A physiological factor which works both for and against the surgeon is muscular tonus with which is associated the phenomenon of tendon retraction. Even with the relaxation obtained by splinting, the tendon is subjected to a constantly varying pull which exerts a force upon any suture line and, despite our best efforts, practically always leads to some separation of the stumps. However, the suture line and the tissues bridging it across are subjected to a constant directional force which determines the lines of structural growth of the new tissue. Without this force, our efforts at tendon repair would probably be fruitless.

The amount of retraction of the proximal stump varies with the length of the muscle tendon and the nature of the surrounding tissues. The longer the tendon and the more tortuous its course, the farther it retracts. Tendons within synovial sheaths retract much farther than paratenon covered tendons. Immediately after division, the proximal stump can be brought down. If, however, the retraction is allowed to persist, permanent shortening occurs and, for this reason, primary suture is the procedure of choice. However, since we are dealing with accidental injuries, we must weigh carefully the advantages of primary suture against the dangers of introducing infection into uncontaminated tissues in our search for the proximal stumps. Under ideal conditions primary suture is justified; if such conditions do

[2] For a survey of the literature on the subject of tendon surgery with extensive bibliographic references, the following articles should be consulted: HESSE, F. Die Behandlung der Sehnenverletzungen. Ergebn. d. Chir. u. Orthop., 1933, 26: 174–264. KOCH, S. L., and MASON, M. L. Division of nerves and tendons of the hand with a discussion of the surgical treatment and its results. Surg., Gynec. & Obst., 1933, 56: 1–39. MASON, M. L., and SHEARON, C. G. The process of tendon repair, an experimental study of tendon suture and tendon graft. Arch. Surg., 1932, 25: 615–692.

[1] Presented in the Symposium on Industrial Medicine and Traumatic Surgery, before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.



a b c d e f

Fig. 1. Case 1. Primary nerve and tendon suture. Laceration incurred indoors. Division of median nerve, palmaris longus tendon, and sublimis tendon of the middle finger with partial division of the sublimis tendons of the ring and little fingers and of the flexor pollicis longus and flexor carpi ulnaris. Operation was performed 3 hours after injury. a, b, and c, Hand on the third postoperative day shows primary healing, with the wrist kept flexed to relieve tension on sutured structure. d, e, and f, Three months after operation, return of function is nearly complete. Of particular interest is the beginning restoration of rotation of the thumb.

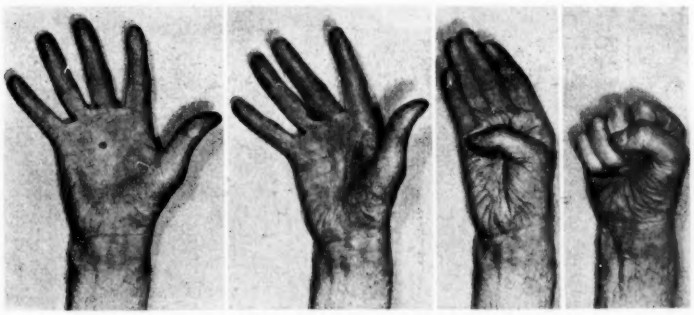
not exist, it is better judgment to cleanse and close the wound, and then wait until healing has occurred before secondary suture is done under aseptic conditions. We have much to gain and only a few weeks' time to lose with such a course.

A study of the histology of tendon repair has shown two phases in the process. The first union between tendon ends is effected by the proliferation of connective tissues about and within the tendon. This proliferation begins a short time after suture, and within a few days the stumps are fused in a fibroblastic splint. The second phase in the process is the repair which proceeds from the tendon itself, an actual proliferation of tendon cells across the gap. This proliferation can be seen as early as the fourth day after suture, but it proceeds quite slowly and does not bridge the defect for from 10 to 14 days. As this tendon cell proliferation becomes an important factor in maintaining union, the sheath tissues begin again to assume their function as gliding tissues; they become areolar and lax, so as to permit gliding of the tendon.

The blood supply for tendon repair must, of necessity, come mainly from the contiguous tissues since the number of vessels traversing the tendon in a longitudinal direction is small, and the vascular flow is diminished by suture material. During the reparative process, it is well for the tendon to lie in contact with vascular and lax peritendinous tissues. If these tissues be dense and fibrous, bony and periosteal, the line of union or the tendon graft is certain to become firmly adherent and non-function results.

The immediate treatment rendered the patient with a tendon injury, will depend upon two factors of practically equal importance. These are the facilities available for carrying out proper surgical repair and the condition of the wound.

The repair of divided tendons, whether in an apparently simple wound or in a very complicated injury, should never be attempted unless every facility for the most careful and non-hurried work is available. Tendon is so susceptible to infection that we feel that as great, possibly even greater, care must be taken to obtain and preserve asepsis as in abdominal or intracranial surgery. The surgeon should not attempt these procedures without adequate trained assistance. Except in very rare cases, a general anesthetic will be required, first, because of the length of time necessary to identify and repair the tendons and, second, because the blood pressure cuff, applied to control bleeding, becomes quite unbearable to the unanesthetized patient. The proper instruments—fine needles, sutures, retractors, and forceps—must be at hand; it is worse than useless to attempt the suture of fine tendons with the ordinary operating room equipment. Lastly, the surgeon himself should be familiar with this type of surgery, should be conversant with the anatomical relations, and should have the patience to

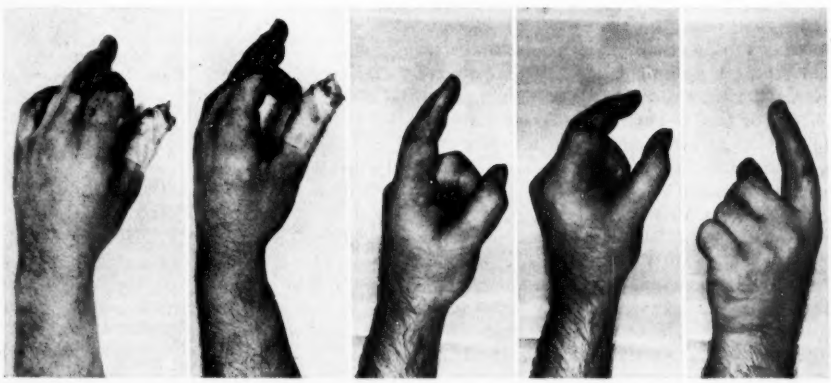


a b c d

Fig. 2. Case 2. Condition of hand 1 year after primary suture of completely divided median nerve, abductor pollicis longus, flexor carpi radialis and palmaris longus, and of partially divided flexor pollicis longus and flexor digitorum sublimis of the middle finger. To be noted especially is the rotation and abduction of the thumb.

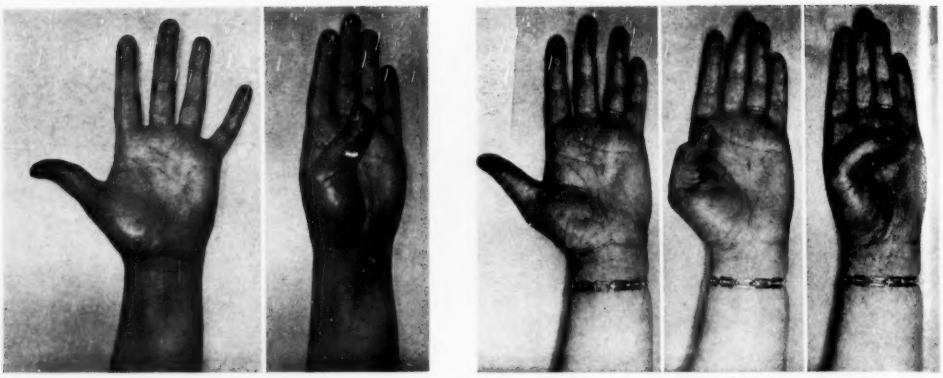
go slowly and carefully about his work. Tendon surgery can neither be undertaken as a minor procedure sandwiched in between other operations, nor can it be relegated to untrained internes or house officers.

The second factor to be considered is the condition of the wound itself. Friedrich's experiments have shown that the time elapsing between the reception of an injury and the surgical care is of considerable moment. Within the first 6 hours after an injury the wound is contaminated, but is not as yet infected, since bacteria as found in dust, dirt, and other foreign matter, are not acclimated to the cultural requirements of human tissue. During the time they are becoming adjusted, it is possible to remove them mechanically by washing and excision, thus rendering the wound relatively aseptic. After this period of adjustment, of 6 to 8 hours, has passed, we must consider the tissues to be infected. The sooner, therefore, a wound is seen and given care, the greater are our chances of obtaining primary healing. Up to 6 or even 8 hours, most wounds can be cleansed, débrided, and closed. In the case of tendons, suture should seldom be attempted in wounds over 4 hours old; we may cleanse, débride the wound, and close the skin, but we must leave tendon repair for a later date.



a b c d e

Fig. 3. Case 3. Multiple lacerations and abrasions of the left hand due to an electric fan injury. Immediate repair 1½ hours after injury. a and b, Before operation. The most important injury is a division of the extensor tendon and joint capsule over the proximal interphalangeal joint of the index finger. c, d, and e, Condition of the hand 6 weeks later. Functional return well started in the index finger. Patient was already back at work at time photograph was taken.



a b c d e

Fig. 4. Case 4. Division of flexor pollicis longus at base of proximal phalanx; delayed suture 11 weeks after injury. a, and b, Before operation the patient was unable to flex the distal phalanx of the thumb. c, d, and e, Eight months after end-to-end suture. There is practically complete restoration of function.

The degree of contamination of the wound must be considered before tendon repair is undertaken. It is obviously impossible to establish definite criteria for wound contamination; this is a matter of surgical judgment. Generally speaking, we can say that wounds received out-of-doors and grossly contaminated with street or garden dirt, are too dangerously soiled to allow tendon repair; whereas wounds received indoors, or by clean objects, generally lend themselves to primary suture. The condition of the patient's hands at the time of the injury, and the nature of the first aid treatment should be ascertained. If the hands were grossly soiled, if rags or dirty handkerchiefs were used as dressings, if the wound was handled or explored without benefit of asepsis, it is usually better judgment to cleanse it thoroughly, close the skin, and delay tendon repair.

The nature of the divided tendon is of importance in the decision. The paratenon-covered tendons, because of the lesser amount of retraction, greater resistance to infection, and greater tendency to heal, do very well with primary suture. The sheath-enclosed tendons on the dorsal and volar surfaces of the wrist, with long and fairly good mesotenons, heal pretty well after primary suture. In case of division of the flexor tendons on the volar surfaces of the fingers and thumb, experience is slowly teaching us that secondary repair is the wiser procedure.

The following brief case reports have been selected from recent cases of Dr. Sumner L. Koch and myself at Passavant Memorial Hospital, to illustrate the criteria of decision between performing primary and secondary repair.

CASE 1. P. H. H., Passavant Memorial Hospital, 17767 (April 29 to May 1, 1934). The patient, male, 33 years of age, slipped on a rug in his home and thrust his left hand through a glass door, receiving a deep laceration of the left wrist. A tourniquet was applied at once; a sterile dressing was placed over the laceration, and the patient went at once to a doctor's office. Here some novocain was injected, the wound was washed, iodine was applied to the skin, and the wound was explored with sterile instruments. The patient was then sent to Passavant Memorial Hospital for treatment. He arrived in the operating room 3 hours after the injury, and under a general anesthetic, the hand and then the wound were thoroughly cleansed with liberal amounts of soap and water, and the injured structures identified. There was found a complete division of the median nerve, the palmaris longus tendon, and the sublimis flexor tendon of the middle finger. The sublimis flexors of the ring and little fingers, the flexor pollicis longus, and the flexor carpi ulnaris were partially divided. The incision was extended upward for a slight distance along the ulnar side of the forearm and the divided structures were sutured. The tendons were first sutured, then the median nerve, and the wound was closed with fine silk sutures in the subcutaneous tissues, and dermal sutures in the skin. A splint was used to keep the wrist in moderate flexion and a pressure dressing was applied. The wound healed by primary intention (Fig. 1, a, b, c), and the patient was discharged on the third day. Examination of the hand 3 months later showed beginning return of sensation over the area of median nerve distribution and that rotation of the thumb was returning (Fig. 1, d, e, f) as further evidence of median nerve regeneration.

CASE 2. M. L., Passavant Memorial Hospital, 10244 (May 1 to May 7, 1932). The patient, male, aged 50 years, received a deep laceration of the wrist on a jagged edge of a 5 gallon water bottle which broke while he was pushing it across the floor. He was brought within 5 minutes to the emergency room of Passavant Memorial Hospital, where the hand and wound were carefully washed and a large sterile dressing was applied. Examination revealed loss of sensation over the area of distribution of the median nerve and inability to rotate the thumb into opposition to the fingers. He was taken to the operating room; a general

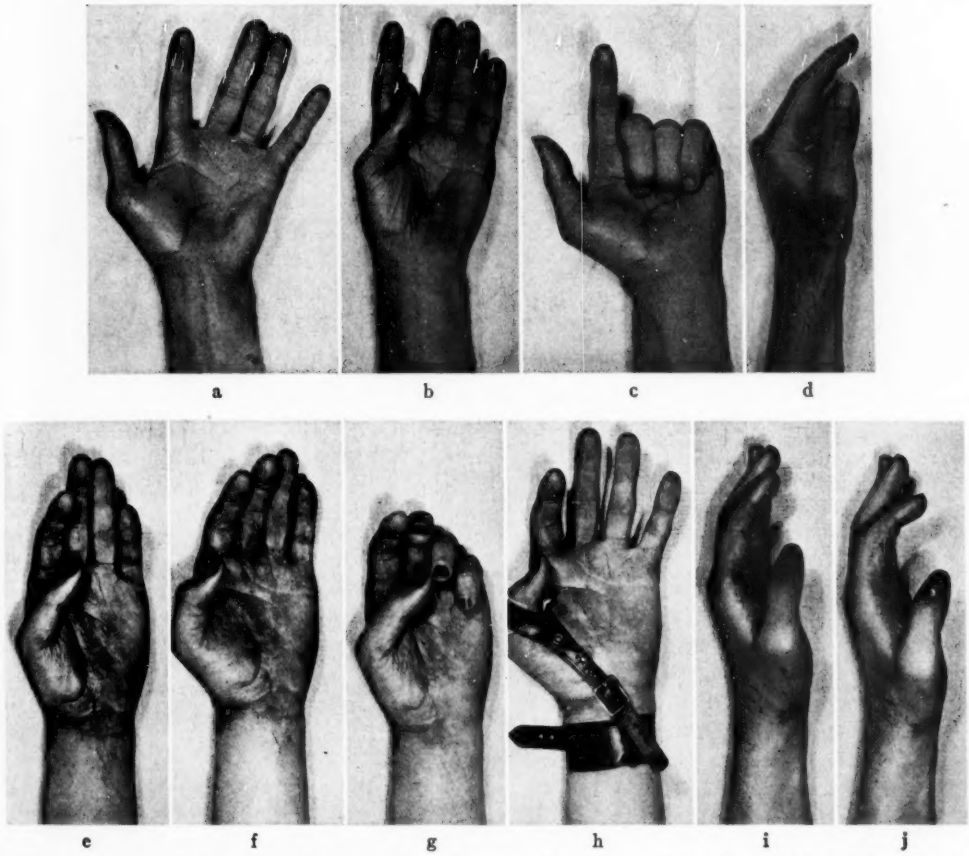


Fig. 5. Case 5. Division of median nerve (partial), flexor pollicis longus, flexor digitorum profundus and sublimis of index finger on broken porcelain faucet 3 months previous to repair. a, b, c, and d, Condition of hand before operation. There is loss of flexion of the interphalangeal joints of the index finger and thumb, loss of rotation of the thumb, and sensory loss on the radial half of the palm and volar surfaces of the thumb and index finger and radial half of middle finger. e, f, g, h, i, and j, One month after operation. Flexion is beginning to return in the thumb and index finger. A strap has been fashioned to produce rotation of the thumb and relax the thenar muscles.

anesthetic was administered, and the soap and water cleansing was repeated. There was found an almost transverse laceration of the radial two-thirds of the volar surface of the wrist with complete division of the abductor pollicis longus, flexor carpi radialis, palmaris longus, and median nerve. The flexor pollicis longus and flexor sublimis of the middle finger were found to have been partially divided. The divided tendons and nerve were sutured with fine silk, and the wound was closed with fine dermal sutures; the wrist was held in semiflexion on an aluminum splint and a pressure dressing was applied. Healing occurred by primary intention, and the patient was discharged on the sixth day after operation. Examination of the hand 1 year later (Fig. 2) showed good motor function, including returning power of rotation of the thumb.

Case 3. S. C., Passavant Memorial Hospital, 18298 (June 11 to June 13, 1934). This patient, male, aged 28 years, injured his left hand in an electric fan and was brought at once to Passavant Memorial Hospital emergency room. There were found numerous lacerations and abrasions (Fig. 3, a, b): (1) Laceration over the dorsum of the proximal interphalangeal joint of the index finger with division of the extensor tendon and of the joint capsule. (2) Laceration and abrasion over the lateral surface of the middle phalanx of the index finger with loss of one-half square inch of skin. (3) Small lacerations over the volar surface of the proximal interphalangeal joint of the index finger. (4) Abrasion with loss of skin over dorsum of the distal phalanx of the middle finger. (5) Laceration over the proximal interphalangeal joint of the middle finger. (6) Laceration on the dorsum of the middle phalanx of the middle finger. (7) Laceration on the volar surface of the proximal interphalangeal joint of the middle finger. (8) A laceration at the base of the nail of the ring finger. The

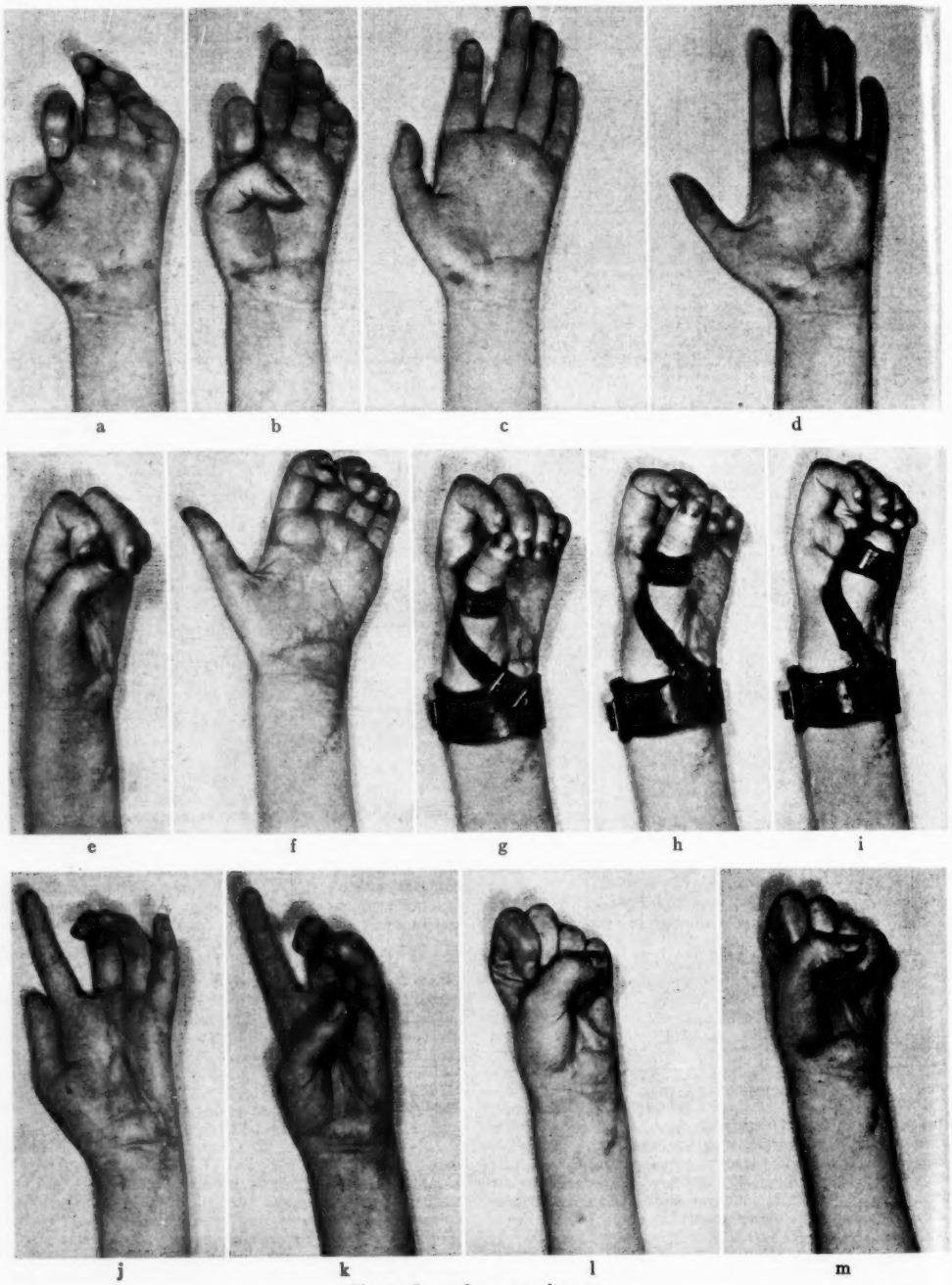


Fig. 6. Legend on opposite page.

patient was a mechanic, and although his hands were greasy and black, they were not contaminated with street or garden dirt, and a primary closure was decided upon. He was taken immediately to the operating room and anesthetized. The whole hand and then the wounds were thoroughly washed with generous amounts of soap and water; devitalized tissue was excised, and primary repair was performed. The joint capsule and the extensor tendon of the index finger were sutured and the skin closed over them. Two denuded surfaces, one on the index finger and one on the distal phalanx of the middle finger, were covered with razor grafts; the other lacerations were closed by suture. An extension splint and sea sponge pressure dressings were applied. The man was discharged on the third day, to return at intervals for dressings. Healing occurred *per primam* and the patient returned to full time work 4 weeks later. The degree of functional return 6 weeks after operation is shown in Figure 3, c, d, e. Subsequent examination has shown further improvement in flexion of the proximal interphalangeal joint of the index finger.

The 3 preceding cases illustrate the indications for primary tendon repair. All 3 patients were seen almost immediately after injury, and operation was performed within 3 hours. In each case a relatively clean object produced the injury; in 1 case, a glass door; in another, a broken piece of glass from a 5 gallon water bottle, and in the third, an electric fan. The hands of the patients were relatively clean; although in the case of the third patient, some explanation is necessary. This man was a mechanic whose hands were constantly subjected to grease and machine dirt. Although at first glance there might be some question as to the advisability of primary suture, it has been our experience that machine shop contamination is not as dangerous as soil or street dirt contamination. Such hands are sometimes quite difficult to cleanse, but we have found that they are usually amenable to primary repair.

The 4 following reports deal with tendon injuries repaired secondarily, at intervals varying from 11 weeks to 4 years after the injury. In 2 instances, no attempt was made at the time of the injury to repair the tendon damage; in 2 instances, incomplete operations were performed.

CASE 4. E. W., Passavant Memorial Hospital, 19569 (October 2–5, 1934). A housewife 26 years of age sustained a deep cut with a paring knife on the volar surface of the proximal phalanx of the left thumb. She treated this herself by the application of an antiseptic and an immobilizing dressing, and healing took place in a few days. She was unable to flex the thumb at the metacarpophalangeal joint following this injury (Fig. 4, a, b). At operation, 11 weeks later, a complete division of the flexor pollicis longus was found. The distal stump had rolled up and retracted to the region of the interphalangeal joint while the proximal stump had pulled upward to the base of the metacarpal, but was prevented from retracting any farther by a well developed mesotenon which was found at the region of the metacarpophalangeal joint. An end-to-end suture was performed and a splint was applied to keep the wrist moderately flexed and the thumb adducted and only slightly flexed. The wound healed by primary intention with complete restoration of function (Fig. 4, c, d, e).

CASE 5. W. V. M., Passavant Memorial Hospital, 14075 (May 18–25, 1933). A dentist, aged 38 years, cut the palm of his right hand on a broken porcelain faucet, February 5, 1933. A tourniquet was applied and the man was taken to a hospital where a tendon to the index finger was sutured, and a search was made for the flexor pollicis longus tendon which was not located. The skin was sutured and the wound healed by primary union. After the wound had healed, he noted loss of sensation of the palmar surface of the thumb, the index finger, and radial half of the middle finger, and loss of flexion of the thumb and index finger. At time of examination, 3 months later (Fig. 5, a, b, c, d), there was loss of flexion of the interphalangeal joint of the thumb and index finger, and sensory loss over the radial half of the palm, volar surfaces of the thumb and index finger, and radial half of the middle finger. The power of rotation of the thumb was absent.

At operation May 19, 1933, the flexor pollicis longus and both flexor tendons of the index finger were found to have been divided. The median nerve had been partially divided just at the point where it gives off the common digital branches, and only the branch going to the contiguous borders of the ring and middle fingers was left intact. The ends of the flexor pollicis longus had separated about 2½ inches, but after being released, moved freely in the sheath, and a good approximation was obtained with some difficulty. The flexor tendons of the index finger were sutured end-to-end and the lumbrical muscle was laid between them. The median nerve was somewhat difficult to suture, since, after excising a neuroma and scar tissue, there were three distal segments to suture to one proximal segment. The incision healed *per primam*, and the condition at the end of 1 month is shown in Figure 5, e, f, g, h, i, j, which show flexion to be returning in the thumb and index finger. A strap was applied to produce rotation of the thumb. One year later, the index function was 90 per cent normal; the distal phalanx of the thumb could be fully flexed, but could not be completely extended if the metacarpophalangeal joint was extended. Rotation was beginning to return to the thumb. The area, still anesthetic to cotton, was hyperesthetic to pin prick, so that there was good evidence of sensory return.

CASE 6. D. H., Passavant Memorial Hospital, 13098 (February 12 to February 19, 1933). This patient, a girl, 16 years, on October 31, 1932, was carrying a jar of tomatoes across the floor when she slipped and fell, broke the jar, and sustained a deep laceration of the left palm. A clean

Fig. 6. Case 6. Division of median and ulnar nerves, of flexor digitorum sublimis of index, middle, ring, and little fingers, and of flexor digitorum profundus of the middle, ring, and little fingers. Secondary repair 3½ months after injury. a, b, c, and d, Before operation. The transverse scar of the injury is seen across the base of the palm. The patient cannot flex the middle, ring, and little fingers at the interphalangeal joints, cannot abduct and adduct the fingers, and cannot rotate the thumb or oppose the thumb and little finger. e, f, g, h, and i, Two months after operation. The fingers can be flexed, but cannot as yet be completely extended. A wrist strap and thumb loop have been applied to rotate the thumb and relax the thenar muscles. j, k, l, and m, were taken 6 months after operation. It will be noted that the fingers can be completely flexed, though they can not as yet be completely extended. The fingers can be slightly abducted and rotation of the thumb is returning.

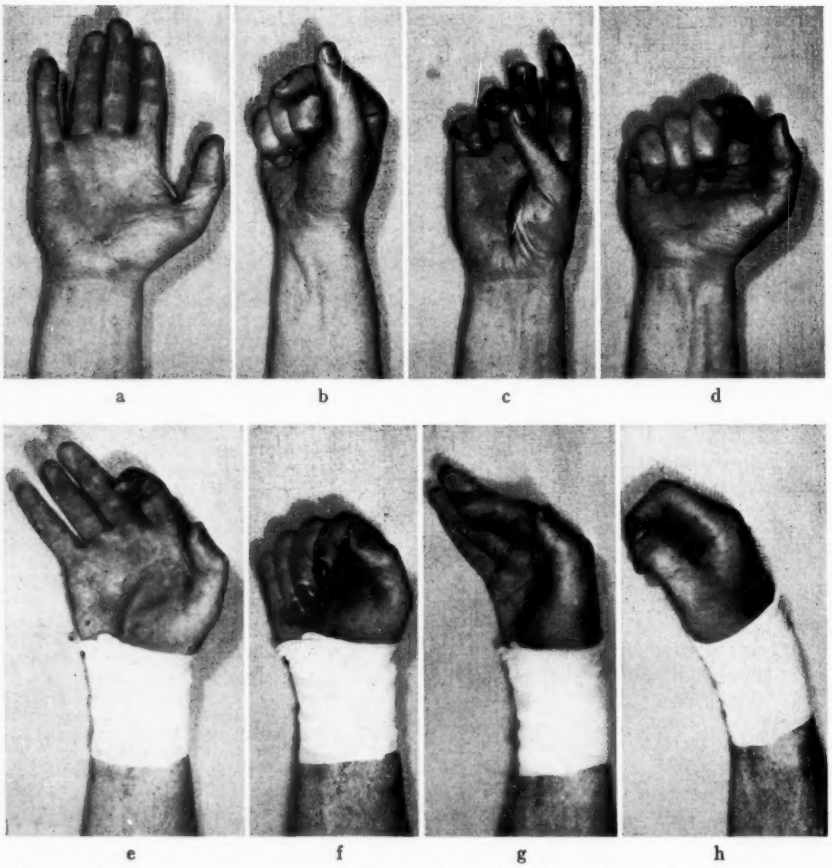


Fig. 7. Case 7. Division of median nerve, flexor pollicis longus, flexor digitorum profundus of index finger, and flexor digitorum sublimis of all four fingers on a broken porcelain faucet 4 years previously. The good rotational function of the thumb is difficult to explain since a complete median nerve division with a large proximal neuroma was found at operation. a, b, c, and d, Condition of the hand before operation 4 years after injury. e, f, g, and h, One month after operation shows returning flexion power in index finger and thumb.

bath towel was wrapped tightly about the hand and the wound was sutured by a physician. The wound healed within 6 weeks; the only complication being a single stitch abscess.

Examination of the hand 3½ months later, February, 1933 (Fig. 6, a, b, c, d), revealed inability to rotate or oppose the thumb and little finger; inability to flex the metacarpophalangeal joints of the middle, ring, and little fingers; disturbed flexion of the proximal interphalangeal joints of these fingers; inability to abduct and adduct the fingers; disability in extension of the distal interphalangeal joint of the index finger; loss of abduction and adduction of the fingers and atrophy of the thenar and hypothenar eminences. There was a well healed transverse scar across the proximal end of the palm extending from the base of the hypothenar eminence laterally and slightly proximalward to the region of the carpometacarpal joint of the thumb. There was practically complete sensory loss over the palm except for a narrow strip on the extreme radial side and loss over the volar surface of the little, ring, and middle fingers and ulnar one-half of the index finger. There was also sensory loss over the dorsum of the terminal phalanges of the index, middle, ring, and little fingers.

At operation February 13, 1933, there was found division of the median and ulnar nerves, the flexor profundus tendons of the little, ring, and middle fingers and sublimis tendons to the index, middle, ring, and little fingers. The distal segments of the flexor profundus tendons of the middle, ring, and little fingers were sutured *en masse* to their proximal stumps. The sublimis tendons of the index and middle fingers were sutured separately to their respective stumps, while the sublimis tendons of the ring and little fingers were sutured as one. The median and ulnar nerves were sutured end-to-end with fine silk. A flexion splint and a pressure dressing were applied.

The wound healed *per primam* and physical therapy was started early. Two months after operation, flexion had improved considerably and a wrist strap and thumb band had been applied to rotate the thumb and relax the thenar muscles (Fig. 6, e, f, g, h, i).

Six months after operation, the function of the hand was excellent. The patient was regaining power of rotation of the thumb, the thenar and hypothenar atrophy was disappearing, and except for some trouble in extending the three medial fingers, her hand was quite useful. Sensory examination at this time showed beginning return of response to pin prick over the proximal three-fourths of the palm.

CASE 7. F. B. McA., Passavant Memorial Hospital, 1268 (June 6–13, 1932). In the spring of 1929 the patient, a man 26 years of age, sustained a deep laceration of the palm of the right hand, when a porcelain faucet handle broke while he was trying to turn off a shower. The wound was covered with a towel and the patient was taken to a hospital where an operation was performed, at which time the tendons of the index finger and thumb were sutured and the wound was closed. Since the accident, he has been unable completely to flex the index finger and thumb, and there has been marked sensory impairment of the palm.

Upon examination 4 years later (June, 1933) there was found a puckered transverse scar in the palm over the region of the transverse carpal ligament, there was sensory impairment to light touch and pain over the area of distribution of the median nerve, and impaired flexion of the interphalangeal joints of the thumb and index finger. A diagnosis was made of median nerve division and division of the flexor tendons of the thumb and index finger. The only incompatible feature in the picture was the lack of impairment of rotation of the thumb (Fig. 7, a, b, c, d).

At operation there was found division of all the sublimis tendons, of the flexor profundus of the index finger, of the flexor pollicis longus, and of the median nerve. The proximal segments of the divided tendons had retracted 1½ to 2 inches above the wrist. The proximal and distal segments of the median nerve were located: the distal segment at the level of the outstretched thumb, the proximal, in the carpal tunnel. Although there was no question as to complete division of the median nerve, the thenar muscles showed remarkably good nutrition and not at all the picture typically present after median nerve division. After careful freeing of the divided structures, the profundus tendon of the index finger and the flexor pollicis longus were united by end-to-end suture; the sublimis flexors were repaired, the neuroma was excised from the median nerve, and end-to-end suture performed. The deep palmar scar and fibrotic remains of the transverse carpal ligament were excised, the wound was closed, and a pressure dressing and dorsal splint were applied. The wound healed nicely and the beginning functional return 1 month after operation is shown in Figure 7, e, f, g, h.

TANNIC ACID AND SILVER NITRATE IN BURNS[1]

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THE application of a new treatment for burns has brought about a new conception of them (1). A burn lesion is not the burn alone but it is the burn plus all those events which develop because the treatment does not check them. The treatment here presented goes far toward controlling all such developments; in fact, the tannic acid-silver nitrate treatment changes the burn lesion into almost a surgical wound.

The treatment of a serious burn is carried out as follows: The patient is given a narcotic which is repeated as often as may be necessary for comfort. Fluids must be forced throughout (2). Grease or oil in any form should not have been used. If such an application unfortunately has been made, it must be removed with ether or benzine before treatment is applied. All blebs are to be opened and all loose skin and other burned tissue are to be removed. A thorough application of fresh 5 per cent tannic acid solution is made by means of cotton swabs. Following this, 10 per cent silver nitrate solution is applied in the same manner. When this second solution is put on, a protective coagulum forms at once. Thus, a task that formerly required up to 24 hours is accomplished in a few minutes. The patient is placed in a tent heated by electric light bulbs and the areas treated are dried and kept dry. Drying the coagulum and keeping it dry is of the utmost importance. In a few days the coagulum begins to loosen and is removed as early as possible. When the crusts come away, large areas and not infrequently all, of the burned surfaces will be found to be entirely healed. Occasionally moisture will be hidden beneath crusts where drying has not been accomplished satisfactorily, and such areas are unhealed when the crusts come away. Where the coagulum is adherent but loose, it is removed, a scalpel being used if necessary. Unhealed areas are treated by the application of oxyquinoline sulphate scarlet R gauze (3), the formula of which is:

R: Oxyquinoline sulphate	grains	10
Chlorbutanol (chloretone)	grains	40
Scarlet R ointment, 5 per cent	ounces	4
Liquid petrolatum	drams	4

A softer ointment may be made by replacing the petrolatum in the scarlet R ointment by oleum ricini. From these ingredients an ointment is made which is heated on a water bath and into which wide mesh rolled gauze bandages are immersed. The warp and woof are impregnated but the mesh is open. This gauze is applied to the unhealed areas in a single layer over which a light pad of dry gauze is placed. Healing is greatly speeded up. This gauze has a wide range of usage in the healing of wounds of all kinds.

The schedule here outlined—the avoidance of grease and oil, the giving of a narcotic, the application of tannic acid followed by silver nitrate, drying the coagulum, keeping it dry and removing it early, forcing fluids, and the stimulation of epithelization—constitutes a superior method of treating serious burns and results in the saving of lives and the minimum of scars and contractures. Under this treatment skin grafting and other secondary corrective measures are very greatly reduced.

The most important result of this treatment is the saving of lives that would be sacrificed by a slower method; the patient too is very comfortable throughout the shortened course of treatment. Greases and oils have served their time and now should be placed in the burn museum among

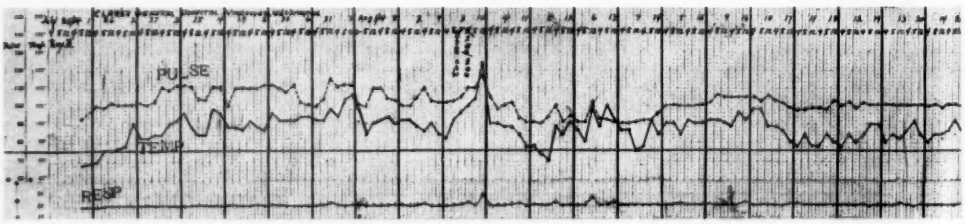

Fig. 1. Case 1. Temperature above 101 degrees only twice, pulse never above 128. Condition remarkably good throughout. (Continued on next page.)

[1]Presented in the Symposium on Industrial Medicine and Traumatic Surgery, before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

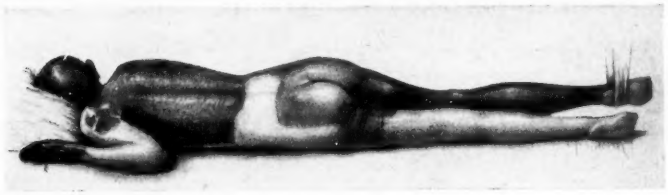

Fig. 2. Case 1, above, R. B. Fifty-four per cent gasoline burn. Treated with tannic acid and silver nitrate 4 hours after burned. Drawing from sectional photograph taken on fourth day, showing back and left side.
Fig. 3. Case 1. Same as seen from the right front.

other antiquities of medicine. Tannic acid alone (4) tans the surface in from 12 to 24 hours, and a further period is necessary that the area may become dry. Tannic acid solution followed by silver nitrate leatherizes the surface at once, and it is quickly and easily dried and kept dry. The surface becomes tanned and dry in minutes instead of hours. The rapid formation of coagulum, through the rapidity alone saves lives.

When grease has been applied and/or the areas are not kept dry, the progress of the patient is not as favorable as here outlined. The temperature, pulse, and blood counts go slightly higher and there may be traces of albumin in the urine. The nearer the outlined schedule is adhered to, the better will be the results. The treatment is best carried out in a small room rather than in a large room or ward.

The loss of body fluids is stopped at once by the prompt sealing of the oozing surfaces. A prolonged concentration of body fluids is inimical to life. The early formation of the coagulum supplies a barrier through which the loss of body fluids cannot and does not take place. Shock is immediately and definitely minimized by this treatment, and patients pass through what otherwise would be the period of initial shock, in good condition. Thus they avoid the first critical period of their burn. Not infrequently, 24 hours after a severe burn, instead of being in shock, the patient wishes to go home or to carry on his business from his bed.

Under past treatment of burns there is an absorption of substances which affect the kidneys, liver, spleen, adrenals, and other internal organs. Such effects have not been noted in patients treated primarily by tannic acid and silver nitrate, in the absence of grease. Urinary suppression, albumin, and other abnormal elements, except sugar in the early specimens, have not been found. Thus this hazard is minimized.

When moisture is applied to a wound over a period of hours, infection develops and the tissues become edematous with some further breaking down. In the few minutes required for the application of the tannic acid and silver nitrate solu-

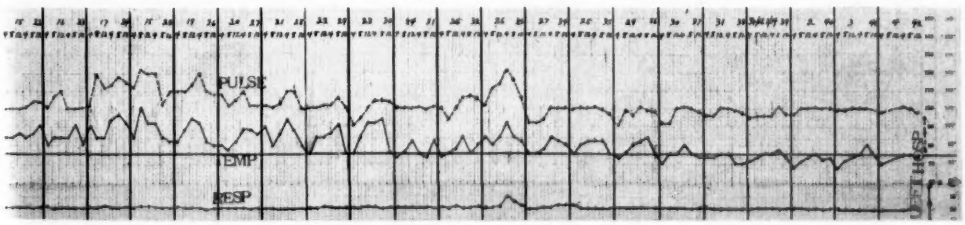

Fig. 1. Case 1. (Continued from facing page.)

TABLE I.—CASE 1. R. B. DETAILS OF CONDITION THROUGHOUT THE 42 DAYS UNTIL HEALING WAS COMPLETE

Date 1934		Fluid intake	Urine	Hemoglobin %	Red b cells, millions	Leucocytes	Small lymphocytes	Large lymphocytes	Transitorials	Polynuclear neutrophiles	Eosinophiles	Others	Sta cell
	25 pm	690		165	6.55								
	26 am	2980	350	135	6.42	10400	21			79		1	
	pm	3820			6.50								
	27 am	3760	330	103	4.68	6650	42			58			
	pm	3760	720										
	28 am	3030	1300	81	4.03	7050	41			57		2	.6
July	pm	3150	780	123	4.90								
	29 am	2700	500	110	5.29	6050	50			49	1		12
	pm	2850	780	109	5.14								
	30 am	2820	700	116	5.31	6900	39	1		60			10
	pm	3000	600	100	5.01								
	31 am	3100	800	110	4.58	8500	30	1	1	64	4		12
	pm	2790	1740	122	5.20								
	1 am	2970	1900	110	4.60	9850	21	5		70	4		20
	pm	3300	1260	100	4.43								
	2 am	2970	2000	107	5.04	12100	17			81	2		
	pm	3060	1320										
	3 am	2890	1950	100	4.90	17600	22	1		73	4		11
	pm	2970	1650										
	4 am	2010	750	107	4.76	27450	17	1		80	1	1	28
	pm	1950	1800										
	5 am	2850	1300	104	4.65	20600	17	1		80	1	1	12
	pm	3060	1530										
	6 am	2950	1850	106	4.63	16000	24	3		71	1	1	5
	pm	2760	2190										
	7 am	2970	1550	106	4.64	15300	18			82			3
	pm	2520	1440										
	8 am	2520	1800	100	5.15	15200	14	2	1	82	1		17
	pm	2850	1740										
	9 am	2810	2150	108	4.51	16200	21			77	2		7
	pm	2816	1350										
	10 am	2760	1100	105	5.32	16000	18	1	1	78	2		12
	pm	2500	1980										
	11 am	2450	1700	103	4.82	12150	20		1	77	2		2
August	pm	2650	1475										
	12 am	2510	1550	100	4.47	14250	17			83			4
	pm	2500	930										
	13 am	2410	1750	108	4.47	13900	16	1		81	2		6
	pm	2510	1500										
	14 am	2620	2100	100	4.59	13150	24	2		72	1	1	2
	pm	2310	1620										
	15 am	2160	1980	106	4.95	12900	23	3	5	68	1		
	pm	2250	1020										
	16 am	2460	1320	100	4.80	17250	20	3		74	3		11
	pm	2048	1920										
	17 am	1920	1440	110	4.96	11950	34	2	1	61	1	1	
	pm	1920	1200										
	18 am	1940	960	105	4.63	9100	26	4	3	66		1	2
	pm	1830	840										
	19 am	1920	800	97	4.33	13350	35			62	2	1	2
	pm	1770	1020										
	20 am	1720	700	102	4.32	15150	30	1		63	5	1	
	pm	1830	1500										
	21 am	1780	850	105	4.52	11000	46		1	53			
	pm	1980	540										
	22 am	1920	800	100	4.93	9300	32			65	2	1	
	pm	1740	840										

TABLE I.—CASE 1. R. B. DETAILS OF CONDITION THROUGHOUT THE 42 DAYS UNTIL HEALING WAS COMPLETE—Continued

Date 1934		Fluid intake	Urine	Hemoglobin %	Red cells, millions	Leucocytes	Small lymphocytes	Large lymphocytes	Transitorials	Polynuclear neutrophiles	Eosinophiles	Others	Staff cells
	23 am	1920	700	100	4.19	8150	35			62	3		
	pm	1590	660										
	24 am	1560	850	96	4.00	8200	35			62	3		
	pm	1980	940										
	25 am	2190	1250	96	4.41	8500	28	1		67	4		1
	pm	1890	1440										
	26 am	1680	850										
	pm	2010	1080										
August	27 am	1560	900	100	4.36	8750	36			62	2		3
	pm	1470	1020										
	28 am	1440	1350										
	pm	1200	1020										
	29 am	1320	1100	110	4.43	12950	36	1		63			3
	pm	1530	540										
	30 am	1560	1300										
	pm	1500	1020										
	31 am	1200	1200	111	4.60	10350	37			59	3	1	1
	pm	1590	540										
	1 am	1320	1100										
	pm	1590	990										
	2 am	1400	1350	110	4.64	13350	37			60	2	1	
Sept.	pm	1590	720										
	3 am	1000	500										
	pm	1590	420										
	4 am	1200	600	107	4.45	9200	46			51	3		
	pm	1590	720										

tions, the tissues do not have time to absorb moisture and become water-logged; therefore, they dry quickly and do not break down.

Instead of the usual blood concentration, we find that the hemoglobin and red cell count returns early to normal. The white blood cell count is low, the staff cells being relatively few throughout the entire healing period. The temperature and pulse rate are surprisingly low at all times, and the organisms of infection do not develop. Moisture taken from beneath intact coagulum has shown no bacterial growth; while that from broken areas showed Staphylococcus albus.

When extremities are involved, they should be placed in slings within the tent to allow the circulation of warm air entirely around them, thus keeping the coagulum dry on all surfaces. Many patients with less extensive burns who usually require hospitalization are ambulatory with this treatment, and not a few are seen by the surgeon only once or twice. Dressings of any kind are not required, the patient being admonished to keep the treated areas dry.

The second critical period, that of infection, is also conspicuous by its absence, because there is little or no moisture or infection beneath the coagulum, as all surfaces are commonly completely healed when it comes away. No cause, therefore, exists for a secondary temperature rise on the sixth or eighth day. The treatment provides an antiseptic covering for the burned areas and one that is insoluble and not absorbable. Coagulum formed by the application of tannic acid followed by silver nitrate is thin and flexible and allows motion, especially turning.

The frequent disturbing of the patient by the applications of the slower method of tanning is avoided; the nurse's major problems are the administration of fluids and the keeping of the coagulum dry. Further local applications are not necessary except to those few blebs which ordinarily make their appearance on the second day. Intravenous and rectal fluids are required for only a short period, as the mouth intake early assumes large proportions under the urgings of a diplomatic nurse. At least 1000 cubic centimeters for every 25 pounds body weight, every 24 hours should be administered. The necessity of administering salt must not be overlooked.

The repeated applications of medication which rapidly become cold and wet the bedding, add to

Fig. 4. Fig. 5. Fig. 6.

Fig. 4. Case 1. Condition when healing was complete. Back of hand and forearm were covered with Thiersch grafts on the twenty-sixth day. All other skin surfaces healed smoothly without contracting scars or disfigurement.

Fig. 5. Case 1. Back and thighs, after healing had been completed. The skin is soft and flexible.

Fig. 6. Case 1. Showing right leg and thigh healed without hypertrophied scar, contractures or disfigurement. Patient left hospital, all healed, on the forty-second day.

the shock at a time that heat is needed. The brief application of these two solutions does not cause chilling, and the bedding once changed, is thereafter dry. It is necessary to open only the head of the tent to give fluids.

The treatment of burns with tannic acid and silver nitrate speeds up healing and shortens the period of hospitalization very greatly. A number of patients with extensive second and third degree burns have completely recovered by the eleventh, twelfth, and thirteenth days; many by the twenty-first, and a 54 per cent burn, on the forty-second day. In every case in which tannic acid and silver nitrate have been used as a primary treatment, the scarring has been minimum. The healed surface is soft and flexible and is covered by a good thickness of epithelium with little scarring. The speedy healing makes necessary a lesser amount of skin grafting or other reconstructive surgery; not that skin grafting or other secondary procedures are entirely unnecessary, but they are very greatly minimized.

Fig. 7. Case 2.

The silver nitrate solution is apparently completely combined with the tannic acid in the surface fluids and is fixed in such a manner that no absorption takes place; for in no case in which this treatment has been applied has there been any evidence of argyria. The only patient who has died following the use of this treatment was a 77 year old man with an 80 per cent burn.

When tissue is destroyed by the direct action of the burning agent and when the primary destruction removes all epithelial islands including those of deep glands, then skin grafting or other reconstruction procedures must be done and the operation had best be done early. Under treatment by tannic acid and silver nitrate if grease has not been previously applied, there is no further breaking down of tissue, the epithelium quickly grows out over the burned area under the dry coagulum, and healing is accomplished with minimum scars and contractures. Details of

nursing must be carried out with this treatment as with tannic acid alone.

The tannic acid and silver nitrate treatment has been used by the author approximately 16 years for the removal of tattooing. It was first used for the treatment of burns about 2 years ago following a burn on his own arm. The result was so superior that he was encouraged to use it on patients with small burns. Finally the treatment proved itself by successfully healing a 54 per cent burn and the patient left the hospital on the forty-second day. Tannic acid and silver nitrate has been found valuable also in the treatment of superficial injuries, which it seals, preventing infection. It is of value too in the treatment of bed sores.

ADVANTAGES

Sixteen points of the superiority of tannic acid and silver nitrate treatment applied in burns are worth consideration:

1. The saving of lives that would be lost through the slower method of tanning.
2. The immediate stopping of the loss of body fluids, thereby preventing the consequent concentration of the blood.
3. The immediate prevention or very definite minimizing of shock.
4. The immediate prevention of the absorption of toxic products.
5. The prevention of infection by the short period of application of moisture and the early drying of the tanned tissues.
6. The saving of the kidneys and other organs from the effects of fluid concentration and the absorption of toxins and infection.
7. The greater comfort of the patient.
8. The fact that the patient is safely carried past the first 24 hours, the most critical period following a serious burn.
9. The fact that the patient avoids the second critical period, that of infection and late absorption of toxic products.
10. The simplification of the nursing problem, especially in the first 24 hours.
11. The prevention of further breaking down of tissues, resulting from long application of wet dressings.
12. The prevention of chilling, resulting from the long application of cold, wet dressings.
13. The formation of a thin, flexible coagulum.
14. The speedy healing of the burned areas with a shortened period of hospitalization.
15. The prevention or minimizing of heavy contracting scars by early rapid healing in the absence of infection.
16. The lessening of the amount of skin grafting and secondary corrective surgery.

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SILICOSIS AND ITS CONTROL[1]

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IT is the purpose of this article to discuss silicosis, briefly outlining salient facts relative to its etiology, clinical manifestations, complications, diagnosis, and prevention. Our remarks are limited to that diseased condition due to prolonged exposure to atmospheres containing free silica. The Committee on Pneumoconiosis of the Industrial Hygiene Section of the American Public Health Association (38) gives the following definition:

> Silicosis is a disease due to breathing air containing silica (SiO_2), characterized anatomically by generalized fibrotic changes and the development of miliary nodulation in both lungs, and clinically by shortness of breath, decreased chest expansion, lessened capacity for work, absence of fever, increased susceptibility to tuberculosis (some or all of which symptoms may be present), and by characteristic X-ray finding.

A certain amount of general information relative to the pathology resulting from the inhalation of dusts has been in existence since the time of Hippocrates (430 B.C.). Some of the early writers discussed such diseases of the lung under the general term, pneumoconiosis. Professor Collis (6) in his 1915 Milroy lectures, furnished us with an excellent historical review of the subject of the industrial pneumoconioses. Rovida in 1871, used the term silicosis in reporting a case of pneumoconiosis, in which he determined, by chemical examination of the lungs, that the condition was due to silica.

Although other dusts, when inhaled in sufficient concentrations over a long enough period of time, have been shown capable of producing a definite pulmonary fibrosis, nevertheless, the pneumoconiosis characterized by nodular fibrosis has to date been shown, clinically and experimentally, to be associated only with the inhalation of dusts containing silica. It has been established that exposure to dusts consisting wholly of free silica (quartz) produces this disease; this has not been shown to be the case for any dust not containing free silica.

Silicosis has been reported in the medical literature from practically all civilized countries. Being an occupational disease, it occurs only in adults, and its distribution among them is limited to those engaged in occupations requiring the use or processing of siliceous materials.

Silica is the most abundant constituent of the minerals and rocks that make up the earth's crust. It occurs in two forms, free and combined. The free silicas as a group are definite compounds in the form of SiO_2. The combined forms are spoken of as silicates. The three most important free silicas are quartz, opal, and flint.

OCCUPATIONAL EXPOSURE TO SILICA

Owing to the fact that the earth's crust contains so great an amount of silica, it is obvious that those occupations concerned with the driving of tunnels, development of highways, and mining, are frequently associated with a silicosis hazard. A second class of occupations exposing the workers to this hazard are those connected with industries having to do with the processing and industrial use of mineral products, such as, the smelting and refining of ores; the use of sand and gravel for structural purposes; the carving of stone, particularly granite; the manufacture and use of silica-containing abrasives, and the processing of the various forms of free silica.

Lanza and Vane (21), in their discussion concerning the prevalence and effect of silicosis, state: "Our very rough, but obviously conservative estimate of the number of workers exposed to silica dust to a harmful degree in the United States is, therefore, upward of 500,000."

FACTORS INFLUENCING THE ACTION OF SILICA DUST PARTICLES AS THE EXCITING CAUSE OF SILICOSIS

Although it has been accepted that silica is the exciting cause of silicosis, there are certain factors which must be considered as influencing its action.

Early workers were inclined to consider that the injury produced by the dust particle was due to mechanical irritation produced by its hard and cutting edges. Gardner (9) has shown experimentally that the inhalation of finely divided carborundum dust, of a greater hardness than silica particles, does not produce the nodular reaction characteristic of silicosis. Collis (7) was one of the early workers to draw our attention to the chemical action of dust. Gye and Kettle have shown that silica in solution or non-crystalline form, exerts a toxic action upon the tissues which leads to the proliferation of fibroblastic cells. Lately Miller and Sayers have reported results of experimental studies which illustrate clearly the

[1]Presented in the Symposium on Industrial Medicine and Traumatic Surgery, before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

TABLE I.—SIZE-FREQUENCY DISTRIBUTION OF VARIOUS INDUSTRIAL DUSTS AS COMPARED TO OUTDOOR DUST

Kind of dust	Number of samples	Median	Average frequency in per cent—Size group in microns											
			0 to 0.49	0.5 to 0.99	1.0 to 1.49	1.5 to 1.99	2.0 to 2.49	2.5 to 2.99	3.0 to 3.49	3.5 to 3.99	4.0 to 4.49	4.5 to 4.99	5.0 to 5.49	5.5 to 5.99
Outdoor dust	179	0.5	56.0	41.0	2.5	0.5								
Sandblasting	9	1.4	1.4	19.7	34.7	20.3	12.6	5.2	2.8	1.6	1.1	0.2	0.2	0.2
Granite cutting	4	1.4	2.0	19.0	33.6	24.5	10.4	4.6	3.1	.6	.9	.3	1.0	
Trap rock milling: Crusher house	1	1.4		13.0	39.0	33.0	10.5	2.5	2.0					
Screen house	1	1.3	2.0	31.5	33.0	16.0	10.0	4.5	2.5	.5				
Disk crusher	1	.9	10.0	48.0	31.0	6.0	3.0	1.0	1.0					
Foundry parting compound	2	1.4	0.5	22.0	42.0	17.3	9.2	5.0	1.5	2.0	.5			
General foundry air	1	1.2		26.0	48.0	17.0	8.0	1.0						
Talc milling	1	1.5		16.0	32.0	20.0	13.0	7.0	5.0	2.0	2.0	2.0		1.0
Slate milling	1	1.7	1.0	13.0	29.0	17.0	14.0	14.0	6.0	4.0	1.0		1.0	
Marble cutting	1	1.5		12.0	37.0	21.0	10.0	11.0	3.0		1.0	2.0	2.0	1.0
Soapstone dust	2	2.4	1.2	16.0	19.0	13.0	11.0	6.0	6.5	4.5	5.5	3.3	2.5	11.5
Aluminum dust	1	2.2	3.0	8.0	20.5	14.0	11.5	9.0	6.5	3.0	3.5	4.0	7.0	10.0
Bronze dust	1	1.5	1.0	12.0	33.5	25.0	21.0	6.0	1.5					

reaction of peritoneal tissues to certain dusts. Only the silica containing dusts have uniformly produced a proliferative reaction. Other dusts have been either completely absorbed, leaving no scar tissue, or have remained unaltered in the form in which they were injected. These latter reactions are classed as absorptive or inert.

Since dust, to exert its harmful action, must enter the finer divisions of the lung, the particle size of the atmospheric dust bears a definite relationship to the injurious effect produced. The silica must be present in the air, in particles small enough to enter the finer air spaces and of such dimensions that the phagocytic cells may engulf them. From our knowledge of these cells, we know that they usually are unable to handle bodies greater than 10 microns in their greatest dimensions. The natural defenses of the respiratory tract probably prevent many particles larger than 10 microns ever reaching the finer divisions of the lung, and such as do are likely to be expelled with the bronchial secretions. The soluble silica plays a definite part in the production of the disease, and the size of the particle also affects the rate of solution; due to the fact that the smaller the particles, the greater the total surface area exposed to the action of solvents.

Table I shows the size-distribution of various industrial dusts as compared with the dust particles observed in the outdoor air in the general atmosphere. It is found that about 70 per cent of the particles found in industrial dusts generally are between 0.5 and 3 microns in diameter. There are, no doubt, many times as many particles too small to count by the method used, but experimentally it has been shown that a great percentage of such submicroscopic particles are not retained in the lungs but pass out with the expired air. Sayers (31) has shown that less than 15 per cent is retained when the finer particulate matter, such as lead in the form of fumes, is inhaled. The greater majority of particles found upon microscopic examination of the lung also fall within the limits of from 1 to 3 microns.

Another reason for considering the size of the particles as affecting the harmfulness of the dust is that it is the larger ones that settle out rapidly, while the rate of falling for the smaller particles is very slow. Figure 1 illustrates graphically this difference: those under 1 micron fall at a rate of from 1 to 3 feet per hour, varying with the specific gravity, while a particle 5 microns in diameter of 7 specific gravity falls about 60 feet per hour. Particles of more than 10 microns would settle out in a relatively short time. The fact that the finer particles remain suspended in the atmosphere for long periods greatly increases their chance of being inhaled.

Thus we may say, from the viewpoint of etiology, that the harmfulness of a given dust is directly influenced by the number of particles it contains of free silica less than 10 microns in

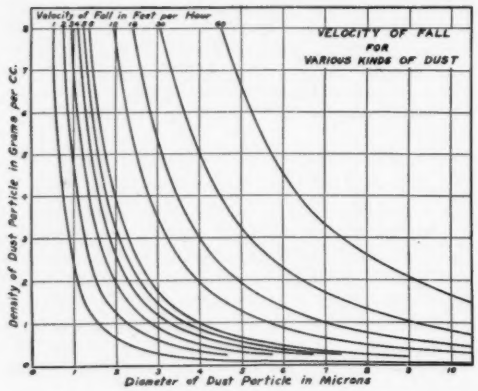
Velocity of Fall in Feet per Hour
VELOCITY OF FALL
FOR
VARIOUS KINDS OF DUST
Density of Dust Particle in Grams per CC.
Diameter of Dust Particle in Microns

Fig. 1. Velocity of fall for various kinds of dust.

diameter, and probably the greatest harm is produced by those between 1 and 3 microns.

The relationship of dust concentration and of the duration of exposure is closely associated in its etiological significance. The rate at which silicosis will develop, excluding certain factors considered as predisposing, depends upon the dosage of free silica. This dosage is obviously dependent upon the amount of silica in the air inhaled and the duration of exposure.

In 1902, a committee of which Dr. J. S. Haldane was a member, reported upon an investigation made to determine the cause of excessive mortality rates from tuberculosis among the Cornish tin miners. This group decided that it was evident that the inhalation of stone dust by these men in the performance of their tasks as miners, was the cause of permanent damage produced upon the lungs. Furthermore, they noted that the condition developed gradually in the case of the ordinary miner, but rapidly in the case of the machine workers who were exposed to greater amounts of dust. Dr. Watkins-Pitchford and Dr. Mavrogordato and other South African workers, in their discussions relating to the etiology of silicosis, emphasize the relationship of the concentration of dust and duration of exposure to the degree of lung changes produced. Mavrogordato has suggested the advisability of intermittent employment as an aid in lessening the amount of changes produced, but aside from the fact that it does delay the reactions, it has not been shown that it could safely be relied on to prevent silicosis, where exposure is to sufficient concentrations. It is intimated that the rest interval allowed by intermittent employment permits the lung to free itself of some of the particles. This avenue of elimination will vary with the types of dust; for example, limestone and coal dust are more readily eliminated than those concentrations with high percentages of free silica. Once the dust is taken up by the cell, the direction of the dust cell in its expulsion from the immediate site of action is toward the lymphatics as well as toward the epithelial lining of the bronchioles, and some portion will be retained. This rest interval may permit the subsidence of the primary reaction which accompanies the inhalation of foreign particles into the finer lung passages. Workers in this country have also shown the relationship of dosage to the severity of the reaction. Reports of the Picher Clinic (32), at the Tri-State District of Oklahoma, Kansas and Missouri lead and zinc mines, which is a cooperative undertaking by agents of the operators, the Metropolitan Life Insurance Company, the Bureau of Mines, and the Public Health Service, have shown clearly the effects of various periods of exposure to silica as met with in the mining processes carried out in the district. Similar studies upon the health of granite workers (1, 30) likewise stress the duration of exposure necessary to produce definite degrees of silicosis.

Some have thought that the relative absence of silicosis in the cement industry was due to the calcium present. However, investigations (36) have led to the belief that the absence of evidence of extensive pulmonary fibrosis among employees in the cement industry is due to the fact that there is insufficient total exposure to free silica, considering concentration of dust and duration of exposure.

No complete reports of pulmonary fibrosis resulting from the inhalation of organic dusts have appeared in the literature. Always when such fibrosis is associated with the breathing of air containing organic dust, either inorganic dust has been shown to be present or at least its absence not definitely proved.

In regard to the presence of other irritating dusts, Chapman, Kessler, MacDonald, Kilgore, and others have reported cases of so called acute silicosis, resulting from the inhalation of air containing high concentrations of silica, along with strong alkali in a fine powdered form. Some have suggested that the rapid action of the silica in the production of pulmonary fibrosis is aided by the presence of these alkalis, because silica is more soluble in alkaline solutions. Kettle (18) failed to demonstrate such actions experimentally and stated that proof is still lacking that any action of the kind may occur. Pathological reports furnish evidence of a definite fibrosis, but the

entire picture differs remarkably from that of the typical silicotic, such as has been furnished by Gardner (10) in his reports upon the examination of tissues from clinical cases of silicosis, as well as his pathological reports made from tissues obtained in his experimental studies.

Sayers, Meriwether, and Lanza (32) reported that of the employees in the lead and zinc mines, those who gave a history of previous coal mining experience developed a definite silicosis in a shorter time than employees of the same age without this experience. This cannot be taken to mean, however, that the inhalation of coal dust hastened the action of silica, for it is doubtful if any of these coal miners had worked where they were not exposed to some free silica; so the total dosage of silica was not the same in the two groups.

PREDISPOSING FACTORS AND COMPLICATIONS

Since the literature of practically all the principal nations of the world contains articles on this subject, it is apparent that no nationality is exempt: that all races are susceptible, is shown by the wide distribution of silicosis. Although the data show that the incidence is higher among the younger miners in districts where the percentage of free silica is high, and among older miners where the percentage of silica is low, age in itself probably is no great factor.

Previous occupation of the men may have a definite influence in predisposing to silicosis, if they have been exposed to dust or to other respiratory irritants.

Since respiratory infection has been shown to be the greatest predisposing and complicating factor in the development of silicosis, certainly the history of present and past respiratory infections will have to be given consideration in the statistical analysis of records upon which such conclusions are based.

The factor of individual susceptibility is often mentioned. Generally speaking, if there be any difference in individual susceptibility, it can usually be considered an acquired, not a congenital, condition. Ickert quotes Bohme and Lucanus and Schulte-Tiggs as stating that it is essential that the individual possess excellent functioning nasal passageways, in order that the self cleansing mechanism may work efficiently. He calls attention to the fact that Irvine, Simpson, and Strachau report the "classical" type of silicosis to be more common among the robust type of individuals with less respiratory reserve. Ickert found some slight variation in the susceptibility of persons according to their type of body build. As a whole the group classed as slender individuals developed simple silicosis somewhat slower than the stoutly built persons; but the incidence of advanced silicosis was greater in the former class, being nearly double that developing in the sturdy workers.

Lehmann's experiments to determine the functional efficiency of the upper respiratory tract in the removal of dust, suggests that abnormalities of the nasal passageways probably play some part in the rapidity with which silicosis may develop. Using dust with a high silica percentage, he found that from 8.3 to 73.7 per cent of the dust was retained during passage of air through the nose. In carrying out this experiment upon 62 miners, he found that the average retention by the nose in the cases of non-silicotics was about 50 per cent; while in the case of miners with silicosis, the average retention was only about 22 per cent.

Chronic bronchial asthma may be considered a predisposing factor affecting individual susceptibility. The spasmodic attacks, if frequent, lead to a reduction in the individual's vital capacity. Aside from the pulmonary fibrosis, other pathological manifestations of silicosis such as bronchiectasis, emphysema, and right heart hypertrophy and dilatation, may be aggravated by this chronic condition.

Chronic infections of a local or constitutional nature may be shown to influence materially the incidence of silicosis.

As regards infection in general, Lanza (20) has stated that in all his experience he can recall seeing but one patient who died of pulmonary fibrosis uncomplicated. The results of the survey in the Tri-State district emphasized the rôle played by infections in disabling silicosis, and mentioned the frequent occurrence of bronchial spirochetosis. Recently, Proske has published reports of additional work along this same line which should do much to stimulate the taking of preventive measures to control such infections in the sinuses and dental regions as may serve as a source of these organisms.

Infections developing along the respiratory tract are of importance. Sinus infections may act by decreasing the efficiency of the upper respiratory tract in the removal of dust from the air passing to the lungs, and also they may be the source of infections that spread to the lower respiratory tract. Acute pneumonic conditions as well as the more chronic lung changes, such as chronic bronchitis, bronchiectasis and bronchiolectasis, emphysema, and pleurisy, all tend to decrease the ability of the lung to rid itself of foreign materials, through lessened lymphatic

drainage and decreased power to force the bronchial secretions and foreign matter from the lungs. The dilated bronchi and areas of emphysema developing in persons as a result of abnormal demands made upon the lungs by glass blowers, divers, professional singers, trumpeters and the like, seldom advance to the point where the individual offers any complaint until infection is present.

In a recent review and discussion of the subject of bronchiectasis, Christie emphasized the infective element as well as other pathological changes associated with the condition. The lung changes accompanying silicosis might be expected to lead to conditions favoring bacterial invasion. Some writers most familiar with the problem believe that the dense areas of fibrosis seen at autopsy or appearing as conglomerate shadows in the X-ray film, possibly are dependent upon an infective process, either present before the absorption of silica or developing in an area of pulmonary fibrosis due to the action of silica.

TUBERCULOSIS AND SILICOSIS

In 1907, Summons of the Miners' Phthisis Committee of Australia, reported that gold miners there who contracted silicosis died of tuberculosis.

The increased incidence of tuberculosis among occupational groups exposed to silica, has been clearly shown in every instance where this hazard exists. Britten summarized the report of the Registrar General of England and Wales for 1921 to 1923 inclusively, and showed the occupational mortality rate for the group of trades classed as "Dusty Trades" to be from 3 to more than 10 times as high as the rate for all occupied and retired males (Table II).

Lanza and Vane (21) show by an analysis of the mortality experience of 12 life insurance companies for the period of 1915 to 1926, that the actual mortality from respiratory tuberculosis among the persons exposed to silica was about 3 times that of a group not exposed to silica. When this comparison is limited to the rates for some of the occupations with a very great silica exposure, such as metal mining, sandstone and granite quarries, the excess is still more striking; the rate being about 10 times that obtained in the non-silica-exposed group.

The initial studies of silicosis by workers in South Africa were started by a demand upon the health authorities to determine the cause of the excessive mortality from tuberculosis, which was increasing at a rapid rate among the gold miners there. The study by Russell and associates of the health of granite workers was prompted in part by the excessive number of deaths reported as due to tuberculosis in the section of Vermont in which the granite industry is located.

Gardner's (11) statement that, "At least 75 per cent of those human beings who develop silicosis die of tuberculosis which may make its appearance at any stage of the disease," stresses the importance of the silicosis problem from the viewpoint of antituberculosis activities. Rist and Donbron advance the theory that there is no nodular fibrosis until the element of infection has entered the picture. Such a theory, however, does not agree with experimental work which has shown that the nodules may be produced in the absence of evidence of infection.

Kettle (17) and Price and others have shown that the tubercle bacillus will grow more rapidly upon culture media to which a small amount of silica is introduced, thus offering a favorable media for the growth of the organism. Gardner (8) has shown that animals exposed to silica when inoculated with a strain of tubercle bacilli of low virulence, will develop systemic tuberculosis and die; while control animals not so exposed usually are not seriously affected by injections of such organisms.

PROGRESSIVE TENDENCY OF THE DISEASE

Since infection has been shown to play so important a rôle in the advanced stages of the disease, the possible relationship of this infective element to the progressive tendency of the disease cannot be overlooked.

Irvine has stated that it is not so much what the condition of the silicotic is today, as what it will become tomorrow. Irvine emphasizes the tendency of the fibrosis to progress even though removed from exposure, and expresses his opinion that it is one of the most serious aspects of the whole silicosis problem. No remedy has been shown to be of value in elimination of the pulmonary fibrosis, although certain improvement in symptoms may be noted after the victim is removed from exposure. According to the observations made by Bohme-Bochum, silicosis progressed after removal from exposure: in 20 per cent of the cases the diagnosis was silicosis grade 1; in 40 per cent, grade 2; and in practically all other cases, grade 3. The course of silicosis among workers no longer exposed to silica dust is adequately stressed in the report of Russell, and the references discussed furnish evidence that, regardless of termination of exposure, silicotics may progress eventually to a more severe and even fatal condition. Such reports from workers most familiar with the condition surely serve to em-

phasize the seriousness of this occupational disease.

Therefore, it may be stated that a full understanding of the true etiological factors accounting for the development of silicosis in a single instance requires detailed knowledge of the individual's occupational exposure past and present, together with facts obtained through a complete physical examination, with particular attention to positive evidence of old or recent respiratory infection. Although a slight mention may be made of the predisposing cause, after all, in the great majority of cases, whether individuals will develop silicosis depends nearly entirely upon the concentration of free silica particles under 10 microns in diameter to which they may be exposed and the duration of such exposure.

CLINICAL MANIFESTATIONS

Early in the development of uncomplicated silicosis, there is seldom anything suggestive about the general appearance which would indicate that the individual is affected by a chronic lung disease. Later, when shortness of breath is becoming evident, there may be a tendency for the worker to be less active and many gain weight. Respiratory embarrassment gradually increases with the increasing pulmonary fibrosis, and hypertrophy of the accessory muscles of respiration is observed. The anteroposterior diameter of the chest increases; there is a widening of the intercostal spaces, with lessening of the elasticity of the lungs, and the chest is best described as barrel-shaped or emphysematous type.

The cardinal symptom is shortness of breath. This, in early cases, may be observed only following exercise. To elicit this symptom and estimate its degree, a uniform exercise test may be carried out as follows: The individual places one foot upon a chair or firm stand, 18 inches in height, and raises his body to an erect position 25 times in 30 seconds. Those with marked respiratory or cardiac disturbances cannot be subjected to such a test, but in the course of examining persons already employed or applying for work, few of such individuals will present themselves. The pulse and respiration is taken with the examinee at rest immediately following the exercise test and after a 2 minute rest period. It is evident that such a test is not one the results of which are affected by respiratory conditions only, but one which is influenced by various factors, such as weight, heart condition, age, general physical condition, and numerous metabolic differences. It does serve as an indication of decreased capacity for work. When we consider all factors, definite information concerning respiratory capacity is available. Regardless of the presence of slight cardiac defects or changes due to age, etc., the individual with appreciable pulmonary fibrosis will exhibit not only shortness of breath following the exercise, but the characteristic altered respiratory rhythm. The expiratory phase is markedly prolonged, often to such an extent that the rate of respiration is much less than in the case of a person with pulmonary infection or cardiac disturbance. Due to loss of elasticity of the lung, the individual cannot empty his lungs rapidly enough to allow for a great increase in respiratory rate. In fact, the rhythm approaches that of the asthmatic before exercise. The condition may be differentiated from bronchial asthma by the absence of the râles and other clinical data. In cases of well established silicosis, prolonged expiration may be elicited by careful observation during the course of physical examination, prior to any exercise test.

TABLE II.—STANDARDIZED MORTALITY FROM RESPIRATORY TUBERCULOSIS IN OCCUPATIONS WITH RATES ABOVE AVERAGE, MALES AGE 20 TO 65 YEARS, 1921–1923, ENGLAND AND WALES

Occupation	Mortality rate (standardized)
All occupied and retired males	149.6
Tin and copper mines, underground workers not superintending staff	1886.0
Tin and copper mines, not superintending staff	1323.5
Grinders in the cutlery tools	1178.5
Metal grinders	636.7
Slate masons and slate workers	512.5
Potters' mill workers; slip makers; potters	411.4

The rôle played by cardiac deficiency may be determined by considering the records of the pulse (before, after, and following the rest period), and the blood pressure determinations.

Closely associated with the development of shortness of breath manifested by the silicotic, is a variable cough. When the cough first becomes noticeable, it is unproductive and is usually brought on by exertion. Later it may be stimulated by the efforts required to carry on usual activity. In most cases of uncomplicated silicosis, this cough is so slight that its presence will not be elicited without direct questioning or observation following exercise.

Decreased chest expansion is also mentioned as characteristic of silicosis. A marked decrease is seldom found until the condition has progressed to the stage at which there is evidence of a lessened capacity for work. In the examination of nearly 3,000 hard coal miners, it was learned that the

average chest expansion of those with silicosis was about 75 per cent of the average for those in a control group. In the same study, it was found that the average chest expansion of those in a group of totally disabled silicotics was about 50 per cent of the average for the controls.

In the industries studied, individuals with definite silicosis have been shown to suffer more frequently from temporary disabling respiratory infection than have the workers who present no signs of silicosis. The clinical manifestations of silicosis, complicated by pulmonary infection, tuberculous and non-tuberculous, cardiac defects, extreme emphysema and pneumothorax, are as variable as are the signs and symptoms of the complicating conditions. The general appearance of an individual suffering from silicosis with infection or other disabling complications usually is indicative of the seriousness of the condition. Loss of strength and weight, prominent supraclavicular and infraclavicular spaces, muscular atrophy, clubbing of the fingers, cyanosis, and edema are rather common findings.

The chest findings present a marked contrast to the usual negative findings elicited upon examination of the uncomplicated silicotic. Adventitious sounds are indicative of pulmonary infection or cardiac embarrassment. In the early complicated case, such alterations may be localized in but one section of the lung field, but later all portions of the lungs are found involved. The changes elicited upon palpation, percussion, and auscultation, will depend upon the severity and type of the infection, upon the extent of emphysema, pleural involvement, or pneumothorax present, and usually are interpreted readily.

A non-tuberculous pulmonary infection complicating silicosis varies from that producing chronic bronchitis to extensive parenchymatous involvement leading to cavitation. The sputum varies from simple, slight, mucopurulent to thick, tenacious, blood streaked material with a foul gangrenous odor. Mixed fusiform and spirochetal organisms, commonly found in the upper respiratory tract, have been shown to play a major rôle in the non-tuberculous pulmonary infections associated with silicosis (Proske and Smith).

Pulmonary tuberculosis has been shown to be a common terminal complication. It is usually present in a chronic fibroid form, and for this reason may exist for some time before laboratory examination of the sputum proves positive. As in fibroid phthisis not complicating silicosis, animal inoculation with the sputum offers the most certain chance of establishing a definite diagnosis.

Temperature varies with the extent and activity or acuteness of the infection complicating the silicosis, and the variation is seldom noticeable to the person affected until the very last few weeks or months of his life.

Several studies on urinary excretion of silica indicate that persons exposed to abnormal amounts will excrete correspondingly large amounts of silica. However, excessive silica in the diet will produce a like increase in elimination, and must be considered. Furthermore, cessation of exposure does not cause an immediate marked decrease in silica excretion. Old silicotics, whose occupational exposure to silica dust had ceased 2 to 10 years previously, were found to be eliminating more than twice the amount of that eliminated by a non-exposed group on the same diet (35). Thus, excessive silica excretion indicates merely excessive silica intake at some time, and its relation to present exposure must be considered with several qualifications.

Tables III and IV indicate the frequency with which the subjective and clinical manifestations occurred in a group of 616 anthracite coal miners, found to have anthracosilicosis, and 135 totally disabled former hard coal miners.

ROENTGENOLOGICAL FINDINGS

While the roentgenological findings of simple silicosis are characteristic, it is not possible to diagnose silicosis definitely upon X-ray findings alone; they should be considered with the medical and clinical manifestations.

FLUOROSCOPIC EXAMINATION

Although a fluoroscopic examination is not relied upon to detect details of pulmonary changes common in silicosis, it does offer certain advantages. Decrease in motility of the diaphragm may be measured. This decrease varies from slight to practical fixation and parallels the respiratory embarrassment shown upon exercise. Frequently, adhesions between the visceral and diaphragmatic pleura may be demonstrated. Knowledge obtained by oblique and lateral fluoroscopic examination of the chest is helpful when for any reason stereoscopic films are not secured. The practice of examining an individual by means of the fluoroscope prior to taking an X-ray of the chest, in advanced cases at least, furnishes information which is valuable in determining the X-ray penetration needed for a good film.

The characteristic X-ray film of the chest will show, in the case of simple silicosis, symmetrically distributed, clearly defined nodular shadows, from 3 to 6 millimeters in diameter. As the condition advances, the nodular shadows increase in size

TABLE III.—FREQUENCY OF COMPLAINTS COMMONLY VOLUNTEERED BY WORKERS HAVING ANTHRACOSILICOSIS SIMPLE AND WITH COMPLICATIONS, COMPARED WITH A GROUP TOTALLY DISABLED BY ANTHRACOSILICOSIS

Group	Number	Percentage complaining of		
		Shortness of breath	Cough	Weakness
Unaffected workers (controls)	361	6.4	2.2	0.8
Those with simple anthracosilicosis	219	32.7	10.7	2.33
Those with anthracosilicosis and infection	397	48.1	22.9	7.9
Those totally disabled by anthracosilicosis	135	100.0	88.0	100.0

TABLE IV.—PERCENTAGE OF WORKERS HAVING SIMPLE ANTHRACOSILICOSIS AND ANTHRACOSILICOSIS WITH INFECTION, SHOWING CERTAIN PHYSICAL FINDINGS (AFTER EXERCISE TEST)

Group	Number	Percentage showing			
		Shortness of breath	Altered breath sounds and/or impaired resonance	Persistent râles	Prolonged expiration
Unaffected workers (controls)	361	1.6	26.5	3.3	0.6
Those with simple anthracosilicosis	219	41.6	84.6	20.6	40.2
Those with anthracosilicosis and infection	397	58.7	93.7	50.4	49.9
Totally disabled by anthracosilicosis	135	100.0	95.0	51.8	78.0*

*Without exercise.

and eventually are found to appear coalesced; this change is gradual and the coalesced areas gradually form large, dense, well defined shadows. With this increase in fibrosis, a compensatory emphysematous condition gradually develops, as demonstrated in the film by scattered areas of increased transparency. When the silicotic nodules develop subpleurally, the visceral and parietal pleura may become involved with the formation of adhesions. Some authorities are of the opinion that usually these large conglomerate areas of fibrosis which produce the massive shadows on the X-ray film, and the pleural adhesions are the result of either previous infection and resulting scar tissue at that site or concomitant infection as the nodules develop.

It is not possible to interpret changes preceding the nodular shadows characteristic of silicosis as presilicotic, unless serial films at different periods of exposure are available. The increase in linear marking, enlarged hilus, and grainy diffuse shadows are all within the limits of what may be considered an essentially negative film. The increase in pulmonary fibrosis producing the slightly irregular if not abnormal markings may be the result of chronic respiratory infection, circulatory changes, age, etc.

The character of the film shadows, once infection has played a part, is dependent upon the severity and type of infection and upon whether infection preceded or followed the exposure to silica. The shadows are less symmetrically distributed; their borders are less defined; the nodular shadows are of such a character that the term "mottling" has been suggested as more descriptive. Pleural thickening and adhesions frequently are demonstrated and the mediastinum, especially after cavities have developed, often is displaced. The diaphragm frequently is irregular in outline, and localized emphysema may be demonstrated by the areas of decreased roentgenographic density. Localized areas of a massive pneumothorax are sometimes found.

DIAGNOSIS

Diagnosis of silicosis is based upon occupational and clinical history, and physical, laboratory, and X-ray findings. Although a diagnosis of silicosis should not be made upon X-ray findings alone; neither should a positive diagnosis be made without a good chest film. Postmortem diagnosis may be made by examination of the lung, pathologically and chemically.

The physician, experienced in the diagnosis of silicosis, familiar with the character of work usually performed by an individual found suffering from the disease, may fairly well demonstrate decreased capacity for work which may be attributed to simple silicosis. To determine the degree of disability, or the cause of disability after infection has entered the picture, usually requires clinical observation for some time; affording an opportunity for more detailed and repeated examination of the individual.

OCCUPATIONAL HISTORY

Since knowledge regarding previous occupational exposure is so important in the final interpretation of clinical and X-ray findings and in the proper placing of individuals at work where they may safely carry on, detailed information of this nature should be secured. The record should

OCCUPATIONAL AND PAST MEDICAL RECORD

NAME Walroy, F. B. NO. 000 PRES. AGE 51 MINE X DATE

AGE BEGAN WORK 14 NO. YRS WORKED 37 COUNTRY BIRTH USA RACE

	OCCUPATION	INDUSTRY	NO. YRS. IN HARD COAL MINES	NO. YRS. IN OTHER DUSTY	NO. YRS. IN NON-DUSTY	REMARKS
PRES.	Contract miner	H. coal	28			(Breast, 4 yrs. (Gangway, 24 yrs
PREV. 1	Company laborer	" "	3			
2	Ordinary seaman	Merchant marine			1	
3	Mule driver	H. coal	2			
4	Door tender	" "	½			
5	Slate picker	" "	2			Dry breaker
6						Estimated time idle.
7						
8						
9						
10						

PAST MEDICAL (INSERT DATE OF ILLNESS IF POSITIVE HISTORY IS RECORDED).

T. B. CONTACT (F OR P) 0 WHEN —
T. B. 0 INFLUENZA 1918 (2 weeks) SYPHILIS 0
TYPHOID FEVER 0 FREQ. COLDS / since 1928 SCARLET FEVER 0
PNEUMONIA 0 BRONCHITIS / since 1928
PLEURISY 1932 CHR. RHEUM. 0
OPERATIONS 0

PRESENT CHRONIC ILLNESS OR COMPLAINTS (INSERT DATE OF ONSET WHEN POSITIVE)

FREQ. COUGH / PRODUCTIVE slight CHAR. OF SPUTUM mucopurulent
NIGHT SWEATS 0 WEAKNESS 0 DYSPNOEA 2 / gradually inc. since 1927 ?
PAIN 0 LOCATION MINERS' ASTHMA
OTHER COMPLAINTS Pain, / sacro-iliac region.

OCCUPAT. RECORD TAKEN BY W.R.J.
PAST MED. RECORD TAKEN BY W.R.J.

Fig. 2. Record chart showing occupational and past medical record.

indicate each specific occupation in each industry in which the individual has been employed and the duration of employment at each job. If the record begins with the present occupation and lists each preceding one back to the time the individual started to work, the data will probably be more complete. Figure 2 shows a form which was found practical in recording occupational history upon a group of hard coal miners.

PREVENTION OF SILICOSIS

This phase of the silicosis problem may be considered advantageously under two main divisions: medical and mechanical.

Medical. Pre-employment and periodic physical and roentgenological examination should be made of all employees engaged in industrial processes where there is a potential, if not actual, exposure to excessive concentrations of silica in the atmosphere. The medical personnel making these examinations should be familiar with the industrial processes in which the individual is to be employed.

In fairness to the individual, his fellow workers, industry, and even the public at large, an individual with evidence of active tuberculosis or extensive healed lesions should not be employed in an atmosphere where there may be exposure to silica dust. The infected individual's condition may be aggravated by such exposure. His fellow workers may become exposed under conditions which, were it not for the presence of silica, might

not be dangerous. Eventually industry will bear the burden of compensation for injury to the health of the employee and possibly some of his co-workers, for with existing conditions, the prevention and control of tuberculosis among the general population will be more difficult. In the absence of infection, silicosis is a slowly progressing disease and develops at such a rate that the individual affected may not become disabled during his ordinary working life. Therefore, if infection can be lessened, the silicosis problem may be controlled much more readily.

Periodic physical examination will serve to detect early evidence of infection and abnormal pulmonary changes resulting from dust exposure. It will then be possible to correct the conditions causing the pulmonary fibrosis, and to prevent the development of disabling pulmonary disease. Unless active pulmonary infection is diagnosed, the individual with a beginning fibrosis or nondisabling silicosis may be safely continued at his present employment, provided the dusty conditions causing it are eliminated. Usually the physician familiar with the patient's condition and the occupational environment to which he is exposed is in the best position to advise his retention or removal from the industry.

Engineering or mechanical control. Prevention of silicosis from the viewpoint of engineering and mechanical control lies in the efficiency of such methods as may be adopted (1) to prevent the escape of siliceous dust into the workroom atmosphere, (2) to remove efficiently dust from the atmosphere in processes in which its escape is not preventable, and (3) to provide mechanical personal protective equipment—for emergency use, or in the operation of such processes as are used only temporarily, or for but short intervals of the working day.

Certain processes readily permit the trapping of the dust at its source; in other processes apparatus may be completely enclosed, thus preventing the escape of dust at any point during operation. Examples of such are the jack hammer with dust trap attached and the enclosed abrasive processes in which mechanically the product being ground is passed in and out without escape of abrasive material used.

The dust in the air of some quarters may be removed by an air filtering arrangement which will secure a rapid exchange of clean air for dusty air. Water sprays and other wetting down methods serve to keep general atmospheres clean or to remove the offending silica. Whenever practical, dusty processes should be isolated from other divisions of the industry, for in this way, the number of employees subjected to a potential hazard is reduced to a minimum.

Occasionally, without decrease in efficiency or increase in cost, satisfactory substitute materials which contain less silica may be found.

Sometimes the cleaning of work places may constitute a source of atmospheric pollution with silica dust. Vacuum cleaning and wet methods may solve this problem satisfactorily; when such methods are not feasible, the cleaning should be done outside working hours when there will be the least number of persons exposed. For the time involved, those doing the cleaning may be protected by respirators or positive pressure helmets.

In the driving of tunnels and in mining which may necessitate the removal of siliceous rock, blasting operations account for a large amount of atmospheric pollution. It has been found practical in many instances to do this blasting after regular working hours or between shifts, sufficient time being allowed to elapse for the air to clear. Water sprays released simultaneously with blasting have been carried out to prevent general dispersion of the dust to other workings in the vicinity of blasting operations.

The part played by a study of workroom environment by qualified personnel is essential to successful control of a silicosis hazard. Analysis of workroom air prior to the installation of methods for keeping the atmosphere safe, serves to indicate the necessity for the institution of methods for dust control and serves to determine the effectiveness of measures employed thereafter. Periodic inspection of all equipment designed for the prevention of atmospheric contamination should be carried out at intervals found to be satisfactory.

Close co-operation between the engineering and medical personnel is essential for economical and safe control of the dust hazard. No one method or equipment has proved effective and practical, but the adoption of those most practical and safe under capable direction may be relied upon to prevent conditions which will cause silicosis.

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HEAT AND MUSCULAR WORK[1]

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MY first experience with the effects of heat on the working man was in September, 1914. It was at this time that I entered the field of industrial medicine. About 5:00 o'clock one afternoon of a very hot and sultry day, the men from the open hearth carried into our small clinic a man with intense cramps in his arms, legs, and abdomen. They gave the story that the man had been working around the hot furnace all day and had been drinking too much cold water. I did not realize what the future had in store and that I was to see many more of these cases in my work as a physician in industry.

HISTORICAL

Heat stroke or sun stroke is the oldest known disease. The ancients associated the disease with Sirius, the dog star, and dog days, probably because in the summer months Sirius follows the sun and is visible in the evening twilight. The oldest records of the disease are the biblical cases. In the 4th Book of Kings, Chapter IV, is found: "And the child grew and on a certain day when he went out to his father to the reapers, he said to his father: My head acheth, my head acheth . . . and when he had taken him and brought him to his mother she set him on her knees until noon and then he died." In the Book of Jude, Chapter VIII, is found, "And her husband was Manasses who died at the time of the barley harvest where he was standing over them that bound sheaves in the field and the heat came upon his head and he died in Bethulia his own City and was buried there with his fathers."

Wakefield and Hail call attention to the confusion of heat with apoplexy as illustrated by Forestus in 1562; and Baglivi, of Rome, in 1694 and 1695 called attention to an epidemic of apoplexy which was confused with sun stroke. Lancisi, according to Levick, was the first to publish evidence of the influence of hygrometry in the etiology of heat effects. In 1789 Dr. Benjamin Rush called attention to a disorder occasioned by drinking cold water in warm weather and described the symptoms of heat stroke very accurately. Andral, of Paris, was the first to note the relation between high atmospheric temperatures and heat conditions. Condie, in 1858, described heat stroke occurring in places other than in the sunlight. He was the first to emphasize the humidity of the air as an important etiological factor. In 1858, Claude Bernard considered the cause of death in heat conditions to be due to purely physical causes; that is, elevation of the blood to such a high temperature. In 1872, H. C. Wood noted "The more violently a muscle is made to contract before subjection to heat, the sooner it becomes paralyzed." Dr. R. R. Sayers and Sarah Davenport of the United States Public Health Service published (April 8, 1927) reports with complete bibliography, giving historical data of heat.

THE PRODUCTION AND LOSS OF HEAT

Under normal conditions the human body produces more heat than is necessary to maintain the body temperature. This excess heat is given off from the body in three ways: (1) by conduction and convection, (2) by radiation, and (3) by evaporation. Heat can be lost by conduction and convection only when the surrounding air temperature is lower than the body temperature and by radiation only when the surrounding objects are at a lower temperature. When the surrounding objects are at a temperature higher than that of the body, the body absorbs heat from them; such for instance as from furnaces, red hot metals, or the sun. When the body cannot lose sufficient heat by these two methods the sweat glands come into action and produce sweat which by evaporating causes heat to be lost from the surface of the body. The amount of heat which can be lost by evaporation depends on the temperature and the amount of moisture already in the atmosphere; the higher the humidity, the less evaporation. Air currents or wind also play an important rôle in heat loss, due to the fact that they cause the air in contact with the body to be changed and hence hasten heat loss. However, when the air temperature is well above body temperature, air movement may have the reverse effect, i.e., hinder heat loss, especially if the humidity is high. If the body is unable to lose sufficient heat, the body temperature will of course rise.

The amount of heat which the body produces increases markedly when a person performs any

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sort of muscular work. Every time a muscle contracts, an extra amount of heat is produced in the muscle. When the person is performing heavy muscular labor, this great amount of excess heat must be lost immediately if the body temperature is to be maintained. In physical work in high temperature and humidity, therefore, there is a marked increase in heat production due to the work combined with a poorer chance for the body to lose heat to the surrounding atmosphere.

What then are the results of working under these unfavorable atmospheric conditions? In the first place, high temperature, especially if associated with a high humidity, limits a man's capacity for muscular work. Second, if the atmospheric conditions are extreme, clinical symptoms of heat cramp, heat exhaustion, and heat stroke may result.

Considering first the early onset of fatigue when working in hot atmospheres, ample experimental and practical evidence is available to prove that a man cannot perform as much physical work when the external temperature is high. It is not just discomfort or laziness on the part of the worker when he fails to turn out as much work on a hot day. McConnell and Yaglou, for example, have shown that at a relative humidity of 60 per cent a person can perform about twice as much work in a temperature of 90 degrees F. as at 110 degrees F. and five times more work than at 120 degrees F. What then happens in the muscles or in the body as a whole which leads to this early exhaustion?

CHEMICAL CHANGES

The chemical changes which take place in a muscle during contraction and which lead to fatigue and exhaustion of the muscle, have been the subject of much research. According to the present theory, the energy for the muscle contraction is derived from the breakdown of phosphocreatine into creatine and phosphoric acid which occurs during muscular contraction. This must be resynthesized continually if muscular contractions are to continue. The energy for this resynthesis is presumably derived indirectly from the breakdown of sugar into lactic acid which also occurs when a muscle contracts. It has been shown that a portion of the lactic acid, ¼ to $^1/_6$, is oxidized and that the energy thus liberated is utilized to resynthesize the remainder of the lactic acid back into glycogen. If the lactic acid accumulates in sufficient concentration, it becomes a limiting factor to the amount of work which a muscle can perform. In physical exercise so strenuous that one is completely exhausted in a short time, the lactic acid may accumulate so rapidly that its oxidation cannot begin to keep pace with its formation, and under these conditions the lactic acid in the muscles and blood may accumulate in sufficiently large amounts to lead to complete exhaustion. In prolonged moderate work, however, even at high temperature the body becomes exhausted without any marked accumulation of lactic acid in the body as a whole and without exhaustion of the supply of sugar (Dill and Edwards, etc.). On the other hand, McCurdy (1932) states: "My belief at present is that we are dealing with a tonic spasm of the voluntary muscles caused by the accumulation of lactic acid and probably intensified by some disorder of metabolism and an added stage of fatigue carried further than usual because of the influence of high temperature and high humidity upon very active muscle contractions." It is, therefore, impossible at present to explain the muscular exhaustion experienced in unfavorable atmospheric conditions on the basis of the chemical changes taking place within the skeletal muscle. It has, therefore, been suggested that the cause of the exhaustion probably is referable to the heart. The heart rate increases not only with muscular exercise and with a rise in body temperature, but also with external temperature even though the body temperature may change but little. Dill, Edwards, and others have suggested that fatigue of the heart muscle, possibly due to the accumulation of lactic acid in it, may be responsible for physical exhaustion when man works at high temperature, since exhaustion comes when the heart has attained its maximum rate.

CLINICAL MANIFESTATIONS

Turning now to the clinical side of the problem, the three well known clinical conditions which result from heavy physical work in a high temperature (and humidity), when the body is unable to compensate for these conditions, are (1) heat cramp, (2) heat exhaustion, (3) heat stroke.

HEAT CRAMPS

Here is a picture of the symptoms of heat cramps: Usually in July or August, a hot, sultry day, the man working in, say the drop forge, gets up early for his turn, eats no breakfast, or at most, takes a cup of coffee, and hurries to the plant. He works about an hour, feels thirsty, and drinks freely of water. About a half hour later he has a spell at work, and eats a cold sandwich probably of thick bread with some kind of meat and onions, returns to his work, drinks more water, and soon notices that he feels a little queer; is sweating

profusely, has a headache, and is compelled to quit and steps out into the air. Immediately he feels a twitching and pain in the muscles of his legs and arms and is forced to call for help. His co-workers put him on a stretcher and he is rushed to the clinic. When he arrives, you see a man who is pale, cold and clammy, down and out. The degree of muscle cramps with associated pain, etc., depends upon the severity of the attack. One of two conditions exists; there is either a state of exhaustion where the man practically passes out, or a state where he has such violent cramps in his arms, legs or abdomen that he cries out with pain. On recovery, you learn that he did not get much sleep the night before; that he has not been eating regularly, that he has been drinking a little more than usual, that he is constipated having paid no attention to his bowel movements, and in general, that he has not given much thought to his health and personal hygiene.

Symptoms of heat cramp. Examination reveals characteristic symptoms and signs:

1. General. The cramps are always preceded by marked sweating. The cramps are painful, tonic spasms of any skeletal muscle but usually of those most actively in use, chiefly the muscles of the calf, the flexors of forearm, and of abdominal wall. The spasms occur at the slightest movement. The temperature varies from 95 degrees to 102 degrees F. The pulse is slightly rapid (usually not over 90 a minute); and thready. Respiration is rapid. The skin is cool and clammy and the blood pressure is low. Talbott reported variation from 118/68 to 132/84. Other symptoms may include nausea, vomiting, diarrhea, dizziness, and mental depression.

2. Blood change. (1) The blood chlorides are very low, the reduction being between 5 and 14 per cent in blood salts. (2) These changes are no greater than in moderate exercise, namely, (a) (HCO_3) slightly below average; (b) lactate and inorganic phosphate of serum increased slightly; (c) protein ions increased because of dehydration with concentration of blood. (3) The total base (serum) is low. (4) The red blood cells are concentrated. (5) The cell hemoglobin concentration is slightly decreased. (6) The total white blood cells are slightly increased.

3. Urine. The chlorides are very low or absent; nitrogen is increased, possibly due to utilization of tissue for food; there is low urine excretion due to water loss in sweat. There does not seem to be any lack of functioning of kidneys as a direct result of heat; there is merely an indirect result due to loss of water and salt through sweat.

Etiology. The present viewpoint is that the loss of base, chlorides, and water from the body in the sweat is the primary factor in the cause of heat cramp (Talbott). The basis for this lies in three facts: (1) the great amount of chlorides lost in the sweat, (2) the low chlorides in the blood and urine reported in cramp cases, and (3) the effectiveness of treating such cases with intravenous sodium chloride.

Normally we take in from 10 to 15 grams of sodium chloride per day in the food. In the kidney, water, salt, etc., passes out in the glomerular capsule, and water (with other substances) is reabsorbed in the tubules. Sodium chloride may or may not be reabsorbed depending on the concentration of sodium chloride in blood plasma. This maintains the sodium chloride in the blood at a constant level under normal conditions. The normal sodium chloride loss in the urine is about 15 grams per day. When this falls below 3 grams of sodium chloride per day, a dangerous level has been reached, according to Talbott and his coworkers. When the sweat glands are called into action, there is a marked loss of salt and water from the skin. Here there is no regulatory function as in the kidney to maintain the blood chlorides at their normal level. The amount of salt lost in the sweat varies with the individual, the external air temperature and humidity, the duration of exposure and the degree of acclimatization. The chloride content increases with duration of sweating. Variations of sodium chloride in the sweat of .06 to .6 per cent have been reported. The salt content, however, decreases with acclimatization after about 3 to 5 days (Dill, Talbott, etc.). The ratio of sodium potassium in sweat varies in different individuals from 5:1 to 3:2, according to the different reports in the literature. The total volume of sweat produced in a day when working at high temperatures may be as much as 5 to 6 liters per 24 hours with a total sodium chloride loss of 20 to 25 grams per day. Just how salt loss through the sweat can lead to muscle cramps is not known. This is not surprising since we, even now, know very little about muscle contraction.

Sodium is the predominant base in the blood serum and extracellular fluids, being about 18 times as abundant as potassium; whereas potassium is the predominant base in human muscle and blood cells (intracellular). Since it is sodium which is chiefly lost in the sweat, one can assume that the sodium chloride passes from the blood to the sweat glands and that the salt of extracellular fluid, in order to maintain salt equilibrium, tends to pass into the blood. (There is, however, no direct proof of chloride depletion of extracellular fluid.) Whether the loss of extracellular sodium

chloride in turn leads to the passage of potassium from the cells into the extracellular fluid under these conditions is not known. If there were a loss of potassium from the muscle cells, one would expect that treatment with a solution of sodium chloride and potassium combined would be better than sodium alone, but this has not proved to be the case. It is at present impossible to explain how a loss of salt in the sweat leads to muscular cramps.

With regard to the possible rôle which sugar plays in the etiology and treatment of heat cramp, the general view at present is that it is not an essential factor (Baetjer). That profuse sweating alone does not lead to hypoglycemia, was shown by Marchionini and Ottenstein who found after 30 minutes of profuse sweating, a rise in blood sugar from 100 to 145 milligrams per cent. However, with exercise and a longer duration of sweating, this may not be the case. Furthermore, treatment of heat cramp with glucose solutions has been reported by some to be unsuccessful. Talbott and Michelsen reported blood sugars of 95 to 114 milligrams per 100 cubic centimeters blood in their 7 cases of heat cramp at Boulder Dam, indicating therefore no significant change, and 95 milligrams as the average for a group of normal workmen at the same time. Despite this, our experience with sugar is most gratifying, not alone, but in conjunction with salt. There is always shock present in heat exhaustion and heat cramps, and the value of glucose solutions is well founded by Crile and his co-workers. Laird also has shown the value of sugar in the fatigue accompanying heat exhaustion.

Podolski further has shown that sugar is a stimulant, needed under such conditions.

Dextrose supplies a source of food and energy that is immediately available. It tends to combat acidosis, protects the liver by contributing to glycogen storage, satisfies thirst, and increases volume of circulating fluids that might be deficient as a result of vomiting and diarrhea. Crile in a personal communication says: "It has been established that glucose carries energy to replace that which is being lost, and salt solution is the electrolytic basis of protoplasm." McCurdy believes that "since glycogen has been diminished greatly with an excessive production of lactic acid, because of acidosis, it can be reconverted into glycogen by the intravenous injection of 1 per cent glucose 300 to 500 cubic centimeters with saline to replace the chlorides of the blood and diminish dehydration." (This is questioned.) And so it would seem that since temperature affects the heart rate, and complete fatigue of the heart muscle causes exhaustion; then sugar does have a place in the prevention and treatment.

Treatment. The treatment of heat cramps will depend somewhat on the severity of the cramps. Mild cases will recover if put to bed and covered with blankets and external heat is applied. We usually give these mild cases, by mouth, a mixture of 10 grains of salt and 5 grains of dextrose, and repeat as needed. In the cases of low temperature, if the patient is not sweating, we believe that it is necessary to keep him well covered and to supply external heat until his temperature reaches normal and he is sweating freely. We have noted that if allowed to expose his arms or legs, immediately they will become cramped. In the severe cases, it is our practice to give intravenously 5 per cent glucose in normal saline administered 500 cubic centimeters to 1 liter or more. Other workers in heat conditions recommend the administration of intravenous saline without the glucose. Mixtures of sodium and potassium or of the usual blood salts have been tried but seem to be of no advantage. In fact, if potassium is added in too great quantity a diuretic effect may be obtained.

Prevention. As I stated before, our first experience with heat cramps was in 1914 and from then to 1932, we were constantly looking for a way in which to prevent heat exhaustion and heat cramps in those departments of the industry where heat is a hazard. In making a survey of the plants and in watching the habits of the men in these various departments, we made the following observations: We noted that, in the crucible where the men were permitted between turns to leave the job, they crossed the street to get a glass of beer. We noted that they always put salt in the beer and that they always returned to the job with pretzels. We also observed that although this was one of the hottest places, the incidents of heat exhaustion were less than in others. In another department, the men insisted on having at their disposal Jamaica ginger. In yet another department, the men insisted on having a barrel of water and into this they poured a package of rolled oats. This was cleaned daily. We noted that the incidents of heat exhaustion were not marked from this department. In one plant, the men were accustomed to eating gum drops and in another plant, they insisted on having peppermint lozenges. In still another, when we asked about the heat conditions, the superintendent advised me that there was no need to go to a certain furnace because all the men employed were negroes. We visited this furnace and on observation we noted that one negro would take something from his pocket every now and then and

chew it. When we asked him what he was chewing, he said, "peanuts" and on asking why he ate peanuts, he said, "I don't know, boss, but the boys before me just told me that if I ate peanuts, I no get them heat cramps." What he was eating was salted peanuts and we learned that this custom had been handed down for a number of years, which was the reason for no heat cramps from that particular furnace. You will note from these observations that the men themselves had learned certain things to prevent these conditions. The beer with the salt, the gum drops, the peppermint candy, the oatmeal water from which they secured potassium salts, and the salted peanuts, all led us to believe that there was some preventive measure in salt and sugar.

Moss credits Haldane with the suggestion that the cramps suffered by miners are due to salt losses. Moss' investigations among miners led him to conclude that during work in high temperatures, some of the men suffered from a great shortage of chlorides in the blood, caused by a combination of excessive sweating and drinking of water with attacks of cramps resulting. He did not believe that the sweating alone could be responsible for the shortage, since the tendency would be toward a concentration of chlorides in the blood. The excessive drinking of water by the miners, due probably to the dryness of the mouth and throat, tended to dilute the blood until, in some of the men examined, the excretion of chlorides by the kidneys showed a marked decrease from normal, despite the enormous excess of urine passed. In order to relieve cramps and also fatigue, Moss recommended the addition of salt to the water drunk by the miners.

On the basis of this discussion, it would appear that the most efficient method of preventing heat cramp would be to replace the salt lost in the sweat by taking extra salt by mouth. This has been recommended for some years and has been in practice in a number of industries. Although no statistical studies or controlled experimental studies have been published to prove the efficiency of this, those interested in the results seem to have been convinced that the incidents of cramp have been lessened since the introduction of this preventive measure. We believe these figures to be the first reported: During the years 1926, 1927, and 1928, of an average yearly employment of 8800, we had 380 heat cases with 2 deaths. During the years 1929, 1930, 1931, and 1932, we tried various preventive measures based on our observations from 1914 to 1929. After these observations and a review of the work done by others, we decided to use tablets of dextrose and salt. These we placed in all departments with a heat hazard and encouraged the men to take a tablet with each drink of water. From 1933 to 1935 we had 196 heat cases, no deaths, with an employment of a yearly average of 7800, and we noted that what cases we did have, were of a much milder degree; in fact, we have not had a severe case of heat cramps during the past 3 years. Whereas we formerly asked the men not to drink too much water, with the use of the tablets we found that they could drink practically all that they wanted without any harm. In another plant during the year of 1931 from 8500 men we had 680 heat cases, but after installing the dispensers and tablets in the year 1935 in the same plant with 9500 men, we had 305 heat cases with a notation that there was a marked lessening degree in the severity of all of them. The tablet used consisted of 5 grains of dextrose and 5 grains of salt. The salt may be added either to the drinking water or furnished in tablet form to be taken with each drink of water. The concentration of sodium chloride which has been recommended for drinking water varies greatly. Concentrations of 0.1 per cent sodium chloride for acclimatized workers up to 1 per cent sodium chloride solutions have been suggested. It is obvious that no arbitrary amount can be set since the salt loss itself depends on so many conditions. Those who recommend salt alone advise a compressed tablet of 16 grains, and suggest that one tablet be taken with each glass of water, assuming that the workers take about 2 or 3 glasses of water each hour during the working period. It has been suggested that potassium might be added with benefit but there is no evidence that this is an improvement over the sodium chloride alone. If this is done, it should be added in small amounts, as the ingestion of potassium may provoke diuresis, and under some circumstances is reported to accelerate the excretion of sodium from the kidneys.

Whether there is any danger from excessive sodium chloride intake as a preventive measure is not known. In healthy men who are losing large amounts of sodium chloride in their sweat each day, the only danger from taking extra salt would be from a local dehydrating effect on the stomach mucosa where the compressed salt tablets lodge while dissolving; whether this is a potential danger is not known. Furthermore, the use of enteric coated tablets would avoid this. In cases of preexisting nephritis or edema, of course, sodium chloride tablets should not be taken, but it is quite unlikely that these patients would be holding heavy jobs in high temperature and humidity. Whether excess sodium chloride intake is a factor

leading to hypertension, one cannot say, as the evidence is contradictory and unconvincing. Baird and Haldane reported that 30 to 40 grams sodium chloride in one day with 500 cubic centimeters to 3 liters of water caused visible edema. It is possible that the men who are not losing much sweat but are taking the extra salt might be getting an excess of sodium chloride. It is, however, scarcely likely that a workman who is not sweating, would take more than 10 tablets containing 16 grains of sodium chloride each, which even with a normal salt intake in the diet, would scarcely amount to as much as 30 grams of sodium chloride per day. Also there is the question of adding carbon dioxide, salt and sugar to the drinking water.

Predisposing factors. Alcoholic bouts are a predisposing factor to heat cramps because of the attending decrease in food consumption with its salt. If accompanied by a gastric irritation with vomiting, an extra amount of salt would be lost from the body. Furthermore, the consumption of alcohol leads to peripheral vasodilatation and an increase in pulse rate, thus placing an added burden on the circulatory system.

Vomiting and diarrhea are also a predisposing factor because of the loss of chlorides from the digestive tract.

Poor living conditions seem to play some part in predisposing to heat cramp and exhaustion, etc. Bock and Dill state that in the summer of 1931 at Boulder City (Hoover dam), a number of deaths occurred among the workmen with a high incidence of heat prostration, while in 1932, only a few cases of cramps occurred. Although the temperature was higher in 1931, the significant difference appeared to be due to better housing conditions which included air-conditioned dormitories, and better food during 1932.

The salt content of the diet would also be important, since a high salt intake would naturally tend to replace its loss in the sweat, and vice versa.

It is an interesting fact that in the steel industry, frequently the most severe cases of heat collapse occur on occasional warm days in the cooler months, for example in October. This is quite readily understood since the body becomes acclimatized to the external temperature whether it is warm or cool, and exposure to a sudden change in temperature finds both the vasomotor mechanism and sweat glands ill prepared to meet this change in temperature.

HEAT EXHAUSTION

Symptoms. The patient is pale, cold, clammy, down and out with weakness, exhaustion and dizziness. The blood pressure is low; the pulse is rapid—average 80; the skin is cool and damp; the temperature is normal, or slightly below or above. Recent reports of experiments at Youngstown indicate that the chemical analysis of blood and urine showed no deviation from normal. Nausea and diarrhea were noted 5 times in 350 cases.

Etiology. The cause of heat exhaustion is not clearly understood, nor is it known why under the same conditions of physical work and environmental temperature, one man will develop cramps and the other will show exhaustion or prostration. Both conditions have somewhat the same general symptoms and both are brought on by physical work in high temperature with marked sweating. One might assume, therefore, a common etiological background. It would appear from recent work, however, that this may not be true, since at least in some cases of exhaustion, no fall in the sodium chloride content of the blood was observed; whereas this appears to be typical in cases of heat cramp. Then we have some men who are critically heat exhausted and later develop cramps. We have experienced cases in which a man was placed at rest in bed in the Emergency Hospital and apparently had recovered from heat exhaustion. He was allowed to go home but some hours later we were called and found him in a severe condition of muscle cramps.

It seems unlikely that the accumulation of lactic acid or the depletion of fuel supply (sugar) in the body as a whole play any important part in heat exhaustion. Talbott and Michelsen found no marked increase in the blood lactic acid in their heat cases and no hypoglycemia and, as explained, in complete fatigue from muscular work in high temperatures, there is no marked increase in the blood lactic acid. It appears likely that the condition of heat exhaustion is due ultimately to a collapse of the circulatory system. The heart rate is rapid; the blood pressure is low, especially the venous pressure as evidenced by the collapsed condition of the veins in some cases, and the blood is concentrated to such a degree that in extreme cases, the blood samples obtained from the vein frequently appear thick and syrupy. The cause of the collapse of the circulation is not known; whether it be fatigue of the heart muscle, stagnation of blood in the capillaries, or loss of salt and water in the sweat with a resulting decrease in blood volume, or a combination of these or some other factor, cannot be said. The condition resembles somewhat the clinical aspects of shock, although here we have no evidence that any toxic substance has been formed, nor any evidence of extravasation. One is impressed with

the similarity between heat exhaustion and the condition exhibited by dogs following suprarenalectomy. In these cases Harrop has shown that a marked loss of sodium chloride occurs through the kidneys. The animals show extreme muscular exhaustion, the blood is concentrated, and the sodium chloride in the serum is decreased.

Treatment. The same as in heat cramps is applied. For mild cases: bed, heat, salt and sugar. For severe cases: heat, intravenous injection of salt and dextrose.

There is always to be considered the question of water metabolism which is closely associated with heat regulation and in turn with circulation and respiration. We do know that water metabolism is influenced by food and work. Then there comes the question of the utilization of water by the tissues. Also there is the question of a thermal control center.

HEAT STROKE

The symptoms of heat stroke are manifested in a very high temperature, as high as to 110 degrees F. The pulse is very rapid; the blood pressure is high; the skin is usually hot and flushed although it may be moist; respiration is deep and labored. The muscles are relaxed or twitching. There is loss of consciousness with convulsions. Autopsy shows congestion and hemorrhage of the brain and meninges.

The onset may be gradual with mental excitement or depression and a dryness of mouth and skin, or it may be sudden with delirium, stupor or coma. The skin is hot, and reflexes are absent.

Treatment. Therapeutic measures include: water spray and fans with rubbing of skin; ice baths, etc., and prolonged rest in bed.

OBSERVATION

Although the etiology may be the same, and the course run by a patient with heat exhaustion may follow a definite sequence, each case is a problem in itself.

In heat exhaustion with cramps, the temperature is subnormal in practically every case. When cramps are present, the temperature may be subnormal, normal, or there may be a rise in temperature as high as 101 to 102 degrees F. At the onset of a case of heat exhaustion, there is a period in which all sweating ceases. If exertion is continued, weakness comes on.

Cramps usually appear after excessive sweating begins. In the worst cases, sweating goes on for a prolonged period; in fatalities it continues until complete collapse.

Most cases do poorly with morphia although it may be necessary to use it for pain. Cardiac pain may be severe with violent contractions that cause heaving of the precordial area.

There may be patients who have felt bad, and who, with stoppage of sweating or profuse sweating, collapse as soon as they are exposed to a cooler temperature, as going outside of a building to the open air.

When a patient in collapse and with dry skin begins to sweat, improvement begins. Temperature must be watched carefully so as not to apply heat after return to normal temperature.

Dehydration can take place to the point that vessel walls collapse; the volume of blood decreases, becoming thick and syrupy in character and black in color.

It has been necessary to bandage extremities. One gains the impression that there is not enough volume to the blood to maintain circulation. There is a point when there seems to be a complete vasomotor collapse. Many men may work an entire shift without evidence of cramps, but develop them after leaving the job or upon arriving at home.

Many cases seem very mild when first brought into the dispensary but grow worse while in bed during the next hour or two. One should guard against permitting patients to get out of bed and to walk if they have cramps.

ETIOLOGY OF HEAT STROKE

The underlying mechanism in heat stroke is probably quite different from that involved in heat cramp. There are a number of theories for the cause of heat stroke. One is that autointoxication results from the action of heat on the body tissues. Another is that the heat regulating center in the brain breaks down. Another is that the essential cause of heat stroke is acidosis. This theory is largely based on experimentally produced hyperpyrexia in animals which have no sweat glands. Hall and Wakefield, and Marsh showed on dogs and rabbits, respectively, that there was a marked accumulation of blood lactic acid with an increase in hydrogen ion concentration and a fall in plasma carbon dioxide combining power. This was accompanied by a rise in blood sugar. Morton, however, reported that intravenous injections of alkalies were without effect in human hyperpyrexia cases. Bock and Dill have shown that heat prostration and death may occur before the acid-base equilibrium is seriously disturbed. A fourth theory is that heat stroke is due to the exhaustion of the sweat glands. Hearne, who studied several hundred cases of heat hyperpyrexia in Mesopotamia, reported that in every

case the skin was hot and dry, indicating suppression of sweating and heat loss by evaporation. The resulting rise of internal temperature, he believed, brought about certain changes in the brain and other tissues responsible for the symptoms. The cause of the suppression of the sweat glands was attributed to previous hyperactivity leading to exhaustion. Leonard Hill also suggested that exhaustion of the sweat glands may be the prime factor in heat stroke. That the sweat glands are subject to partial exhaustion was shown by Whitehouse, who reported a decrease in the amount of sweat with an increase in duration even when water was drunk. Furthermore heat stroke usually occurs most frequently after several days of an extreme heat wave. Hearne believes that the onset of heat stroke can be predicted by the appearance of a dry skin indicating suppression of perspiration and the accompanying increase in frequence of micturition, and that under such circumstances preventive cooling treatment can be successfully applied.

It seems quite probable that there is more than one factor involved in producing heat stroke, but at any rate, the resulting rise in body temperature to a level incompatible with proper physiological functioning, is probably directly responsible for most of the symptoms.

CONCLUSION

In conclusion then it is evident that we are still a long way from understanding the physiological basis of the effects of work in extreme heat. From the clinical viewpoint, however, at least we have made some progress in the past few years by the use of salt and sugar in the prevention and treatment of heat cramp. With the present interest in this problem, we are looking forward to further progress in this field.

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ANALYSIS OF FIVE HUNDRED INTRA-OCULAR STEEL INJURIES[1]

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IN an analysis of 500 steel injury cases, I have come to the conclusion that the making of the diagnosis offers the greatest difficulty, and at times is likewise fraught with danger. To my mind, the dangers of diagnosis far outshadow the operative procedure and the great or small amount of trouble or infection which often follows the entrance of steel in the eye.

At times diagnosis is very difficult to make; in fact the presence of steel in the eyeball may be entirely overlooked unless a careful history is obtained. In my cases, I have found that, in the order named, the occupations of die setter, boring mill operator, general machinist, auto mechanic, blacksmith, and handy man job, are the ones which show the greatest number of eye injury cases. Moreover, the specific instance or instances of injury and the detailed explanation of the injury are necessary. In several of my cases, men have had two to three seemingly minor traumas in the same day, thereby clouding the issue of the important one. Subjective symptoms appear to be of little worth in arriving at a conclusion, for the entrance of a small bit of steel in the eye is often absolutely painless and the patient may be totally unaware of an accident. In these cases most stress in the diagnosis must be placed on the objective findings. Visual tests offer little aid, as unless evident damage has been done, the vision may be normal to the cornea, lens, or iris. In 8 per cent of my series, the entrance wound was extremely small, necessitating a careful search to find it, and in at least half of this number of the cases, no external wound could be found as the injury was 2 to 3 days old. Therefore the diagnosis settles down to the examination of the deeper structures. I have found that fine floaters offer the best clew in these cases as they have been present in the greatest majority of them. Fine or pin point opacity in the lens at the periphery or elsewhere, is of great importance, whereas fine lesions in or about the retina or choroid seldom have been seen immediately following the injury.

The corneal microscope and slit lamp have been of great aid for fine wounds in the cornea or lens, but in certain types of cases, especially those of several days' duration, little aid is obtained. To me, therefore, the X-ray film has been the sheet anchor upon which to fall back. I have made its use a routine procedure in my practice, even when there seemed to be no definite indication, and the results have been surprising. By X-ray picture, I do not mean the film obtained at the average surgeon's office, as such plates are seldom of much value. For the diagnosis of intra-ocular steel, say ½ by ½ millimeter in size, it is often necessary to take 3 to 6 plates at different angles before a definite conclusion can be reached. In my series I have a case in which steel was overlooked by one good X-ray laboratory and found by another. It is evident, therefore, that not only is the X-ray plate most important as a diagnostic aid but it is the best means of diagnosis obtainable. Exact localization is extremely difficult, and where ½ to 1 millimeter means so much, i.e., just in or outside the globe, its extreme importance is readily seen. After the steel has been properly localized—and this is often subject to variations as noted—the operative procedure to be used must be considered.

In my series, the selection of operation has been peculiarly influenced by the laws of my state and the surrounding states. Compensation laws differ; hence the mode of attack must conform in some degree with the economic side. In those cases with steel posterior to the lens and the lens uninjured, the posterior route was the one of choice, even with the danger of subsequent retinal detachment. In all cases in which the lens has been injured, the anterior route was used. It was found that a large operative opening for the magnet point was superior to one in which the point was difficult of entrance, as it entailed less danger of added trauma in the posterior opening. In practically all my cases, the patients were men direct from shops, hence dirty. As a routine procedure, installation of 2 per cent mercurochrome, followed by a thorough irrigation of the eye with 1:3000 bichloride was used. Moreover the mouth was examined for any evident foul, decayed teeth and, if possible, they were extracted at once.

In my early cases, boiled milk was used as a foreign protein, later typhoid serum, and now the hemo-protein of Parke Davis & Co., as the dose is smaller. I am unable to state with any degree of accuracy the effects of foreign protein injections, although I have used such a procedure as in all operative cases. In this series, I have had 32 cases in which the foreign body was not magnetic steel, or was magnetic steel in combination with some other substance such as rubber or bakelite. In

[1]Presented in the Symposium on Industrial Medicine and Traumatic Surgery, before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

several cases the foreign bodies were brass, copper, zinc, and as many were bits of glass. In these cases, two factors appeared to be of most importance: (1) the location of the foreign body; (2) the amount of pure luck in its extraction. I might add that I have been blessed with my share. I have 2 cases of copper in the ciliary body for more than 10 years which have caused no trouble; 3 of brass in the retina and sclera with no inflammatory symptoms; and 2 cases with iron in the periphery of the lens, one 20 years old and the other 5 years old. No cataract has developed, as apparently the foreign body has acted as a bung in a barrel. However, when a definite diagnosis of intra-ocular foreign body has been made, it has been my procedure to use any and all means that will extract the foreign body, if iron or steel, but if of other substance, the localization will decide the course to be pursued. I have found that the eye will stand a large amount of operative trauma at times with surprisingly good end-results.

Complications of minor or major importance developed in over 88 per cent of my cases. In not quite 12 per cent, there was no reaction and no specific loss of vision. Just to what to attribute this in 12 per cent of the cases, is a mystery to me as they were varied types. Possibly the patient's own resistance, lack of infection carried in, or possibly lack of fault in my technique, furnish the explanation. Three patients developed sympathetic ophthalmia; they all disregarded instructions to report at intervals for check up. I have had 12 cases of beginning sympathetic irritation, which subsided promptly on enucleation of the offending eye and suitable medication. I am therefore not in the dread fear of this complication that I was years ago, for I believe that it can be readily handled if it develops while the patient is under observation. One case of gas bacillus panophthalmitis secondary to steel injury had a favorable outcome following enucleation. Detachment of the retina following steel extraction has been difficult to handle; as with it other complications have arisen to increase the hazards of operative correction.

The removal of traumatic cataract has been urged in the anterior route cases, and seldom has the swollen lens caused undue trouble following the injury.

Detachment of the retina has occurred in approximately 14 per cent of those posterior operations in which the eyes were not enucleated. The insurance companies are not prone to spend extra money for medical care for the correction of a detached retina, and in my state, Illinois, for traumatic cataract cases. The insurance companies feel that the best results will not pay for the cash spent. In my state, many cases of traumatic cataract go about uncorrected for this reason, and what might be a good result is checked otherwise.

TABLE I.—RESULTS

	Per cent
Panophthalmitis	18
Uveitis necessitating enucleation	16
Phthisis-bulbi	4
Detached retina	14
Traumatic cataract with good prognosis	33
Fundi damaged including retina and choroid plus damage to iris	22
Those with final normal vision	12
Those with 75 vision	8
Those with 30 vision	20
Those with less	50

From the standpoint of good end-results and of the operative procedure for intra-ocular steel injuries, I have come to the conclusion that industry would profit greatly if (1) employees' teeth were given more care, (2) all patients with eye injuries of every description were sent to an oculist for diagnosis and treatment, (3) the compensation laws of all states were the same, (4) the employer was prevailed upon to handle the after complications.

In the analysis of my cases as to the pathology and vision, Table I shows a summary of results.

The above record of the final results is anything but enviable, but there are several factors to be considered if better outcomes are to be assured. The most important is prevention of injury. The National Safety Council has for years waged a campaign along this line, and it has undoubtedly borne some fruit, but when the injury has taken place, its severity will determine to a great degree the final outcome. It appears to me then, that when the diagnosis of the presence, size, and exact location of intra-ocular foreign body has been properly made, we have done the major part for our patient. The surgical side, depending as it does upon the location for complications, at this time does not offer much aid.

REPORT OF 1935 SURVEY OF MEDICAL SERVICES IN INDUSTRY BY THE AMERICAN COLLEGE OF SURGEONS[1]

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DURING the past year the medical services of 192 industrial organizations have been personally surveyed. To date the medical services of 1,314 establishments which serve 3,220,000 workers have been under survey by the American College of Surgeons. Of this number 708, or approximately 55 per cent, are approved by the College. This relatively high percentage does not mean that 55 per cent of all industrial medical services merit approval. It should be borne in mind that the surveys of the College have been directed principally toward the larger industrial organizations, in which the percentage of organized medical services is much higher than in the smaller establishments. Only a low percentage of the smaller firms have medical services that as yet merit approval; although it is gratifying to note the growing interest manifested by the smaller establishments in improving their organization for such service. This growing interest on the part of both large and small organizations, and their desire to receive approval from the American College of Surgeons has materially promoted cooperation and a closer working relationship between industry and the College.

TREND OF INJURY RATES

It is of interest to review recent experiences in the field of industrial medicine and traumatic surgery. From 1926 to 1934 there has been a reduction of 57 per cent in injury frequency rates, and a decrease of 37 per cent in severity rates, according to the National Safety Council report. The public utilities have made the most progress in reducing their injury rates.

The year 1934 shows an increase of 5 per cent in both frequency and severity rates over the year 1933. This is due to augmented industrial activity, wherein the new untrained workers, and the older employees who may have become careless in their work, were likely subjects for accidents. Furthermore, many safety and medical services were severely curtailed or allowed to disintegrate during the period of low industrial activity. A rather sharp increase in severity rates may be expected in some industries, when the time lost from occupational diseases, such as silicosis, is included in the compilations.

It is highly recommended that each industrial medical department compile an annual statistical summary, including its injury rates, its illness and injury experience, and its costs. A comparison of such summaries from year to year will not only reveal the relative efficiency of the medical and safety services, but will also serve to uncover any existing weak points, and thus future objectives of the medical services will be indicated.

ACCIDENTAL DEATHS

The National Safety Council reports the number of accidental deaths in the United States for 1934 as shown in Table I.

SEVEN PRIMARY CAUSES OF DEATH IN THE UNITED STATES IN 1934

According to the information released by the Bureau of the Census, accidents, in the order of importance as a cause of death per 100,000 population, have moved from fifth place in 1933 to fourth place in 1934, as shown in Table II.

WORKMEN'S COMPENSATION LAWS

Since the scope and the extent of medical service in industry are greatly influenced by the Workmen's Compensation Laws, the trends and changes in the laws are worth considering.

Florida and South Carolina have enacted Workmen's Compensation Laws during 1935. North Carolina and West Virginia have made provisions in their laws to cover occupational diseases. New York has added "any and all occupational diseases" to its previous schedule of 27 diseases. The term "injury" has been held to cover some

TABLE I.—ACCIDENTAL DEATHS

	Number
Total	101,000
Motor vehicle	36,000
Home	34,500
Occupational	16,000
Other accidental causes	17,500
Disabling injuries	9,821,000
Wage loss, property damage, medical expense	$3,500,000,000

TABLE II.—PRIMARY CAUSES OF DEATH

1.	Heart disease	240.2
2.	Cancer	106.3
3.	Nephritis	87.3
4.	Accidents	80.0
5.	Pneumonia	79.6
6.	Cerebral hemorrhage	76.8
7.	Tuberculosis	56.5

[1]Presented in the Symposium on Industrial Medicine and Traumatic Surgery, before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

occupational diseases in Massachusetts and Oklahoma, so there are now 15 states and the District of Columbia in which occupational diseases are recognized, and compensation is awarded for the resultant disabilities.

The Workmen's Compensation Laws of Kentucky and West Virginia have elective provisions concerning silicosis. West Virginia has a medical board for the handling of silicosis, and Massachusetts has a division of occupational hygiene in the Department of Labor and Industry, and a provision for industrial disease referees selected from a list compiled by the Board of Registration in Medicine. California, Maryland, Michigan, and New Hampshire have appointed committees to study occupational diseases, although the committee in California is restricted to the study of silicosis only. Undoubtedly, specific legislation covering occupational diseases will ultimately follow these investigative studies.

As a result of the extension and amplification of the Workmen's Compensation Laws, which might be viewed as a broad sociological measure, and of the increasing manufacturing processes with attendant health hazards, added responsibility is being placed upon the employer. As a consequence, more efficient function is being expected from the medical service, particularly in its preventive phase. The following suggestions, therefore, which embody the working principles of the Minimum Standard, should be observed by all industrial medical services:

1. A definitely organized plan for medical service.
2. A definitely designated staff of qualified physicians, surgeons, and attendants.
3. Adequate emergency, dispensary, hospital facilities.
4. Pre-employment and periodic physical examinations to be made only by a qualified medical examiner.
5. Education of the employee in accident prevention and personal hygiene.
6. Elimination or control of all health hazards.
7. Adequate medical records, accessibly filed in the medical department under medical supervision and responsibility.
8. Supervision over the sanitation of the plant and all health measures, by the physician or surgeon in charge.
9. An ethical and co-operative relationship with the private practitioners.
10. The use of approved hospitals.

Our surveys have revealed that better organization of the plan for medical service, a higher standard for physical examinations of employees and records thereof, adequate medical supervision of the service, and the elimination or control of health hazards, offer the greatest opportunity for advancement in the field of industrial medicine at the present time. This statement is made in full cognizance of the splendid progress that has occurred in accident prevention, in the control of infection, and in traumatic surgery, but these advancements may be classified as accomplishments, while the former represent an existing need.

A certificate of approval is granted to an industrial establishment in which the medical organization and service is fully approved and is of such a nature as to give reasonable assurance of continued compliance with the Minimum Standard. This certificate, which is similar to that for hospitals, has stimulated considerable interest among industrial executives. As a consequence, many industrial medical services have recently been reorganized and definitely improved in order to merit a certificate of approval from the American College of Surgeons. This response from industry is most gratifying. In order that the certificate of approval may always be significant of "adequate care of the ill and injured in industry," appropriate care will be exercised at all times to insure that such certificates are granted only to the industrial medical services that merit such recognition.

OPHTHALMOLOGY AND OTOLARYNGOLOGY

SURGICAL CORRECTION OF DEFECTS DUE TO PARALYSIS OF MUSCLES OF THE EYES AND LIDS[1]

MEYER WIENER, M.D., F.A.C.S., St. Louis, Missouri

THE century mark has not been reached since Diffenbach first announced that he had effected a cure in a case of convergent strabismus by dividing the internal rectus muscle. In the middle of the eighteenth century, the charlatan John Taylor had effected cures by operation, but he evidently did not know himself just what was necessary in the technique, and carefully avoided giving out details as to his prodecure.

Eye muscle operations developed gradually after that. Aurand quoted Velpeau as having inaugurated the treatment for paralytic squint, followed by Guepin de Nantes, and later von Graefe, who formulated the indications in 1862. He concluded that correction of the right superior oblique is best done by tenotomy of the left inferior rectus. Knapp was the first to advance the inferior rectus for paralysis of the superior oblique. Eperon, in 1889, traced in historic detail the whole question and reported 6 successful cases in which patients were relieved by advancement of the inferior rectus on the same side. Jackson advocated the more logical method of transplanting the superior rectus backward and outward. Recently Aurand reported a case of diplopia due to paralysis of the superior oblique, completely relieved by transplanting the inferior half of the external rectus and the temporal half of the inferior rectus to a point 3 millimeters from the inferior temporal margin of the cornea. This gives the pull downward and outward, exactly what the paralyzed oblique lacked. The method, to me, seems more sound than any. Wheeler advocated advancement of the superior oblique, especially for excessive elevation in adduction. He admitted that the technique is not easy. A simpler way of effecting a similar result, provided one wished to utilize the oblique, would be to expose the tendon between two hooks without cutting the superior rectus, and either resect or tuck the tendon. This can be easily accomplished in 10 minutes' time with little trauma to the tissues.

For paralysis of the sixth nerve Dransart transplanted the superior oblique to the attachment of the externus. The same year Hummelsheim reported 2 successful cases of paralysis of the external rectus by transplanting a strip of tendon from the outer half of the superior and inferior recti to the insertion of the paralyzed externus tendon. O'Connor greatly improved Hummelsheim's operation by transplanting the nasal halves of the vertical recti. By leaving the temporal half attachment to help pull outward and taking away the nasal halves, reducing the pull inward, a considerable increase in abduction was secured. Earlier, he had suggested utilizing a strip from the margin in suturing to the transplant, intended to lessen the tension. Moncado transplanted the superior rectus to the tendon of the externus, and then took a strip of the internus and attached it to the insertion of the superior to replace the superior rectus.

I am presenting a method which has given me even better results because of its simplicity and greater ease of accomplishment. The externus is exposed, split down the center, cut off about 15 millimeters from its attachment, and the upper half is sewed to the superior rectus tendon; the lower to the inferior. In this manner, the sound tendons of the vertical recti are not unnecessarily mutilated. By attaching to the nasal half of the vertical tendons, a greater effect can be gained. One can always section the nasal portions of the vertical recti later if he wishes, but I have not found it necessary to do this. When contracture has occurred in the opposing internus, a recession is made first.

Third nerve paralysis is a most distressing deformity. Jackson first suggested transplanting the tendon of the superior oblique to the insertion of the internus. He had performed the operation on the cadaver, and had believed it would work. He also suggested that the operation might be supplemented later by splitting the externus and attaching the upper half to the superior and the lower half to the inferior. He expressed belief of the possibility, in a young person, of re-establishing a limited field of binocular fixation and stere-

[1]Presented before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

Fig. 1. Scheme showing method of transplanting strips from paralyzed externus to tendons of superior and inferior recti.

opsis. Independent of this knowledge I performed this operation (20) with most satisfactory results. The superior oblique is very readily exposed subconjunctivally, by first placing the hook under the superior rectus and feeling the resistance of its attachment just as though one were to work on it. Then, reversing it without changing its location, and pulling in the opposite direction, backward, the resistance of the oblique attachment is felt and its tendon pulled forward. After it is exposed between two hooks and stretched, a Weber canaliculus knife is slid along, the tendon toward and into the pulley, the cartilaginous pulley cut with a sawing motion, and the tendon is cut off to a suitable length and sewed to the sclera just above the insertion of the internus. This prevents upward torsion. There is a tendency to leave the tendon too long, which was my early mistake. The lid is raised by a modified Lexer procedure, a strip of fascia lata being used as a hammock. An incision is made in the skin

Fig. 2. First step in modified Lexer operation. Two incisions have been made above brow and one in lid. Reverdin needle is seen ready to draw strip of fascia up to first opening in brow.

in the middle of the upper lid, thus exposing the tarsus and cleaning it of orbicularis. Two incisions are made above the brow down to the occipitofrontalis, one on either side. A Reverdin needle is passed from one opening over the brow, down, under the skin to the opening in the lid; the fascial strip is drawn up and the end is sewed to the occipitofrontalis tendon. The Reverdin needle is then passed from the other incision above the brow to the lid opening; the strip of fascia is drawn up, a round toothpick having been first slipped through the loop of fascia to deter-

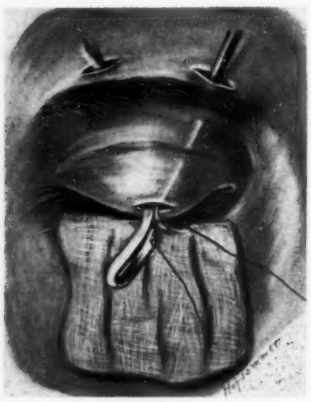


Fig. 3.

Fig. 4.

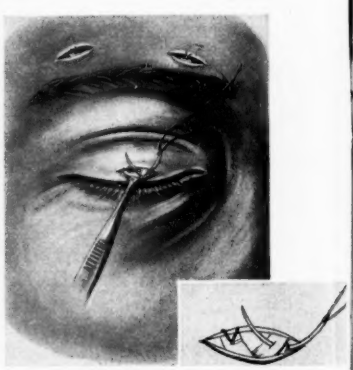


Fig. 5.

Fig. 3. Second step in modified Lexer operation. Reverdin needle ready to draw up strip of fascia into second brow incision.

Fig. 4. Third step in modified Lexer operation, showing how toothpick holds fascia strip in the desired position while sutures are being placed.

Fig. 5. Fourth step in modified Lexer operation. Final suture of fascia to tarsal plate.

mine, by upward traction, where to anchor the strip end on the brow. The strip is then fastened to the tarsus by two buried silk sutures.

I recently had a case of congenital paralysis of the inferior rectus, with paralysis of the superior oblique and weakness of the internus and externus. The inferior oblique seemed overactive. I exposed the inferior oblique, cut it off about 12 millimeters from its attachment to the orbit, and sewed it to the sclera just to the nasal side of the paralyzed inferior rectus, and 4 millimeters closer to the cornea. The newly transplanted muscle is beginning to function and there is a definite improvement in the patient's appearance. The inferior oblique is easily exposed through a conjunctival incision in the lower cul-de-sac, a hook being introduced well to the temporal side of the insertion. On drawing the hook nasally, the inferior wall of the orbit is hugged, the resistance of the attachment is met, and the tendon is pulled into the wound.

In spasm of the inferior oblique, secondary to paralysis of the opposite superior rectus, McCool considers beneficial graduated tenotomy of the oblique made across the belly of the muscle.

Fig. 6. Shows how adhesive makes traction on cheek, bringing up the lower lid to cover the eye, with no pull on the sutures anchoring the upper to the rectus.

McDanold transplanted the lower half of the externus and internus to the normal insertion of the inferior rectus in paralysis of the latter. He also performed tenotomy of the superior rectus.

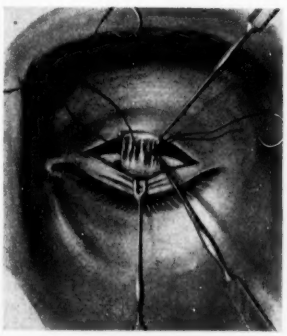
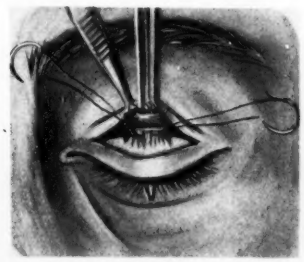


Fig. 7.



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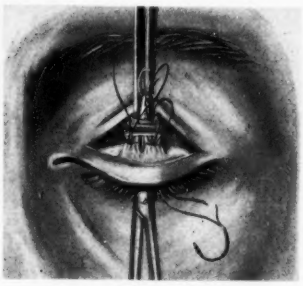

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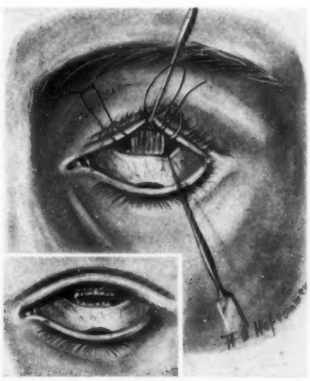


Fig. 10.

Fig. 7. Scheme drawing showing the levator tendon grasped between two hooks and the sutures being put into position.

Fig. 8. Levator tendon has been cut and opening is being made through the fascia and conjunctiva into the upper cul-de-sac.

Fig. 9. Suture being drawn into cul-de-sac.

Fig. 10. Final suture to tendon of superior rectus.

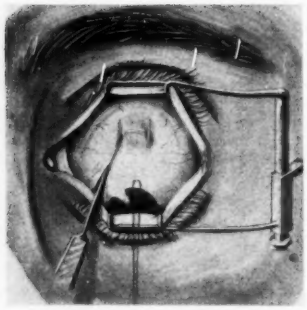
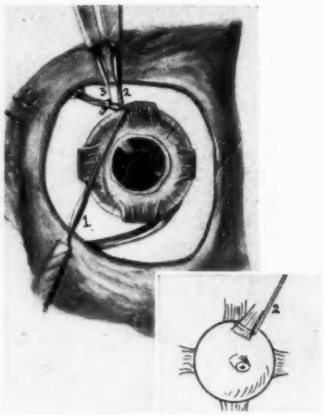


Fig. 11.



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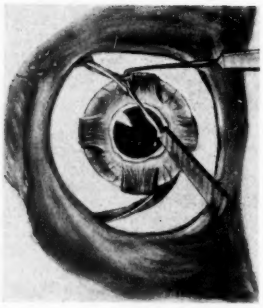

Fig. 13.

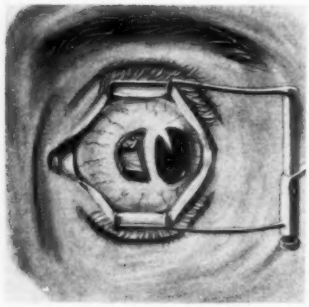

Fig. 14.

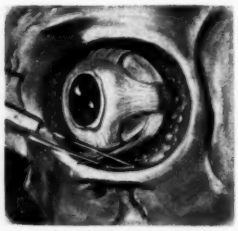

Fig. 15.

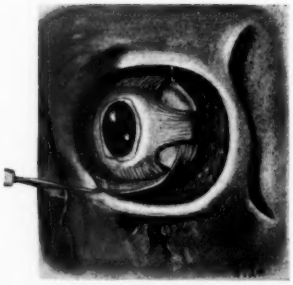

Fig. 16.

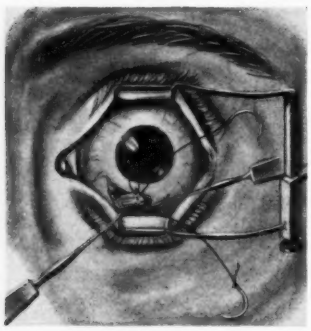

Fig. 17.

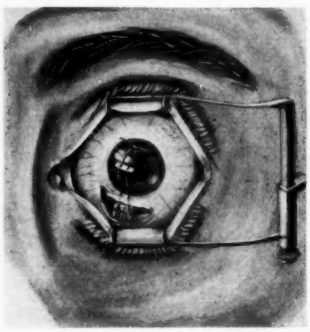

Fig. 18.

Fig. 11. First step in exposing tendon of superior oblique. Hook is introduced in conjunctival opening, slid under the tendon of the superior rectus and traction is exerted forward until resistance of its insertion is felt.

Fig. 12. Hook at *1* in position shown in Figure 11; *2* indicates hook reversed and pulled to feel resistance of oblique attachment (insert); *3* shows hook pulling tendon forward.

Fig. 13. Weber knife slid along stretched tendon to and into pulley where the pulley is cut through with a sawing motion of the knife and the tendon is freed.

Fig. 14. Tendon sewed into position above insertion of internus before closing the conjunctival opening.

Fig. 15. Schematic. Hook in first position well to the temporal side of the insertion of inferior oblique resting on the floor of the bony orbit; *2*, shows it drawn nasally until the inferior oblique insertion is encountered.

Fig. 16. Schematic. Hook has gone as far as it can be pulled. Tendon now ready to be pulled forward into conjunctival opening.

Fig. 17. Tendon pulled forward, stretched between two hooks, and suture placed, ready to cut, just beyond the suture.

Fig. 18. Stitch ready to be tied to sclera over the conjunctiva.

Posey, Chance, and O'Connor performed similar operations.

Operations for the relief of ptosis involve 3 principles:

1. The folding, shortening, or advancement of the partially paralyzed levator. This, in my experience, is not at all satisfactory.

2. The utilization of the action of the occipitofrontalis muscle. This is to be used when a sound superior rectus is not available. The modified Lexer, with the fascia lata hammock, has given me the most satisfaction in this type of case.

3. The utilization of the action of the superior rectus. Motais, in 1897, first described this method of transplanting a strip of tendon from the superior rectus to the anterior surface of the tarsus. Many modifications of this operation, all using the same principle, have been set forth. Two years ago, before the American College of Surgeons in Chicago, I utilized Motais' principle, but reversed the procedure, attaching the paralyzed levator to the intact tendon of the superior rectus. It has the advantage of being easier to perform and not so precarious as the original Motais operation. In addition, it leaves no dent in the middle of the upper lid. In reviewing the literature, I found that it had already been suggested by Cannas, and later by Arranquez. If this method is carefully carried out, it hardly admits of failure. The tarsus is exposed by an incision across the center of the upper lid near the upper border of the tarsus; the main portion of the levator near the tarsus is exposed between two hooks; two sutures are placed close to its insertion in the tarsus, and the levator then is cut off about 6 millimeters from its tarsal attachment. A pocket is made, with a straight, blunt scissors, through the levator and fascia about 15 millimeters above the upper border of the tarsus and through the conjunctiva into the upper cul-de-sac. The speculum is introduced, and the conjunctiva is dissected down to expose the superior rectus tendon, which is freed of capsular attachment. The sutures are drawn into the upper cul-de-sac and sewed, one to each side of the superior rectus tendon about 5 millimeters back from its insertion. Fine silk sutures are used. No suture is required for closure of the conjunctival incision, and only one skin suture is necessary in the lid. The eye is protected with a light dressing by pulling up the lower lid by means of a broad piece of adhesive stretched from the cheek to the forehead, which eliminates pull on the upper lid and effectively covers the globe. No dressing is needed after 48 hours. The adhesive strip is applied at night until the lid closes of itself.

Two methods are recommended for sagging lower lid in the defect resulting from facial palsy. A triangular piece can be excised from the temporal third of the lower lid with the lid margin forming the base and the apex down, deep sutures can be made, drawing the cut edges together, thus tightening the lower lid margin and bringing it flush with the globe. Its effect is not altogether permanent but it is more satisfactory than anything else I have tried. I have thought of using a different method on the next case, which I believe would be better. A strip of fascia lata is anchored to the internal canthal ligament; it is run under the lid margin subcutaneously to the outer corner, and sewed, tightly stretched, to the external canthal ligament and periosteum of the outer orbital margin. This, I believe, will hold the lower lid firmly against the globe and prevent the disagreeable constant flow of tears, as well as add greatly to the patient's looks.

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MOTION PICTURE STUDY OF LARYNGEAL LESIONS[1]

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THE motion picture film has been found of inestimable value in teaching the younger student clinical pathology of the larynx. Even in the larger clinics it is not always possible to have at hand the various types of laryngeal lesions for teaching purposes. To have an accurate record of a large variety of pathological cases for screen presentation is obviously advantageous not only for the teaching of the student, but also for the benefit of the general practitioner whose advice most of these patients seek early in their difficulty. Not only the general practitioner should be made to appreciate the importance of voice changes, but the public in general should be made to realize that persistent hoarseness is the danger signal of the larynx. Because the hoarseness which commonly complicates an ordinary cold subsides spontaneously, most persons consider this symptom a trivial condition. Unfortunately, however, this is not always true. Any patient who has had a persistent hoarseness over a period of 10 days or 2 weeks should be given a thorough examination with the laryngeal mirror, for it is only in this way that an early diagnosis can be made of tuberculosis, syphilis, carcinoma, and tumors of the larynx. The importance of an early diagnosis cannot be stressed too vigorously, since many of these conditions in their early stages are amenable to treatment.

The most essential requisite in obtaining motion pictures of the vocal cords depicting various pathological conditions, is an adequate exposure of the structures of the larynx. This is best accomplished in my experience by the use of the suspension laryngoscope following the technique so ably described by Lynch (2). The use of the suspension laryngoscope is extremely simple and, when properly employed, gives a most excellent view of the laryngeal structures (Fig. 1). The hypopharynx, pyriform fossæ, and base of the tongue are, likewise, exposed to direct vision. This method permits the free use of both hands in all surgical procedures within the larynx. The tremendous advantage of such a procedure is obvious. The vocal cords can be retracted for subglottic examination by means of a retractor or a wooden spatula placed between the cords for abduction when cauterization or coagulation is necessary. Small tumors can be grasped and traction can be made to the opposite side in order to expose the base, thus facilitating dissection. Punch forceps are not used when operating on these types of cases. My experience with them has been that an excess of scar tissue is formed in the healing process. I have obtained better results by grasping these smaller growths with fixation forceps and, while making traction to the opposite side, carrying out sharp dissection with the laryngeal knife for the removal of the growth. Such a procedure usually insures a smooth, straight cord when healed.

Endolaryngeal surgery is simplified by the use of the suspension laryngoscope and, whereas benign growths are readily handled, malignant ones require more careful selection. Only the early intrinsic types of carcinoma are suitable for endolaryngeal surgery. These lesions are removed by dissection followed by coagulation. The results achieved are equally as brilliant as those reported by Lynch (3). Extensive malignant conditions require more radical methods. Whereas a few of the accompanying illustrations have been taken under local analgesia the vast majority of cases are given general anesthetics by choice. A combination of gas, oxygen, and ether are used routinely except in those cases in which cauterization or coagulation is contemplated. For the past 7 years chloroform has been used exclusively when electrosurgical measures are considered. This procedure was adopted only after a tragic experience while coagulating a lesion on the vocal cord. A spark was accidentally created; there was a sudden explosion followed by an ignition of the ether fumes. The patient suffered severely from burns and shock and rapidly developed a pneumonic condition which proved fatal on the third day after operation. Chloroform is non-inflammable and non-explosive and is considered the only safe general anesthetic to use when the use of electrosurgical methods is considered.

In reviewing the lesions presented, attention must be called to the physiological function of the arytenoids and false cords and the protection thus given the true vocal cords. The bechic action of the larynx and vocal cords in the expulsion of the tracheal secretion is most interesting to observe. The synchronous vibration on expiration demonstrates that any pathological condition existing on one or both cords must interfere with phonation.

Multiple papillomas of the larynx are by far the most common pathological lesions found in chil-

[1]Presented before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

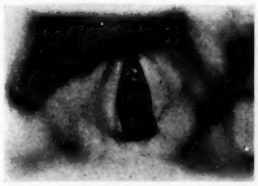

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

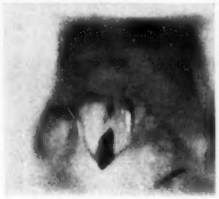

Fig. 7.

Fig. 8.

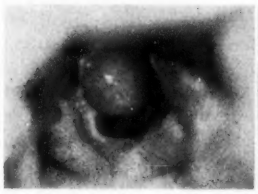

Fig. 9.

Fig. 10.

Fig. 1. View of a normal larynx.
Fig. 2. Papilloma growing from right vocal cord.
Fig. 3. Multiple papillomas on right vocal cord.
Fig. 4. Multiple papillomas completely filling laryngeal aperture
Fig. 5. Papillomas of left vocal cord in adult.
Fig. 6. Postoperative view of Figure 5.
Fig. 7. Vocal nodules on both cords.
Fig. 8. Postoperative view of Figure 7.
Fig. 9. Cystic fibroma attached to left vocal cord.
Fig. 10. Postoperative view of Figure 9.

dren (Figs. 2 and 3). The extent of the growth may vary from a small patch of papillomas to complete obliteration of the glottic chink by the growths (Fig. 4). Removal of these growths under suspension laryngoscopy can be accomplished, but the problem of recurrence is one which has not as yet been solved. Many cases of multiple papillomas are cured after the first or second removal from the larynx, and other cases, identical in every respect, defy every known method for their eradication. During the past 2 years, following the removal of early cases of papilloma, we have used small doses of X-ray after operation as advocated by Foster. While a few cases have responded satisfactorily, many other cases have recurred repeatedly regardless of the manner of removal or other therapy instituted. Multiple papillomas respect no portion of the larynx; they will grow from any part, even from the subglottic region. Much is yet to be learned about the successful treatment of these distressing conditions. The clinical course of papillomas in adults (Figs. 5 and 6) is apparently different from that observed in children. They do not recur with the same rapidity or frequency as in children; however, the continued presence or recurrence of papillomas in adults is viewed with alarm and usually is considered as a precancerous lesion which should be watched for any malignant change.

Vocal nodules (Figs 7 and 8) are the result of voice abuse and are seen in patients who persist in using an inflamed larynx or indulge in straining the voice. The majority of such cases respond to vocal rest, but when this fails they become candidates for surgical removal. Fibromas of the cystic type can become very large, interfering considerably with phonation and respiration as shown in Figures 9 and 10. It is appalling that in this day and time of modern medicine, an intelligent individual should allow a growth in the larynx to reach such a size before seeking relief.

Angiomas are frequently seen occurring on the vocal cords resulting from the too vigorous use of the voice with a rupture of a small vessel on the surface of the cord (Figs. 11 and 12).

An early diagnosis in malignant conditions is imperative if intralaryngeal surgery is to be successful. As stated above, only the earliest malignancies are amenable to intralaryngeal surgery. While excellent exposure will facilitate the oper-

Fig. 11.

Fig. 12.

Fig. 13.

Fig. 14.

Fig. 15.

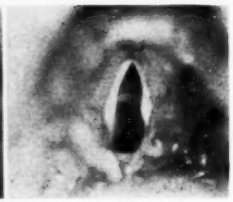

Fig. 16.

Fig. 11. Angioma of anterior third of free border of right vocal cord.

Fig. 12. Postoperative view of Figure 11.

Fig. 13. Intrinsic carcinoma of right vocal cord.

Fig. 14. Carcinoma of mouth of esophagus and postcricoid region showing early infiltration of arytenoids and normal vocal cords.

Fig. 15. Supraglottic tumor, carcinoma grade 3, attached to lateral surface aryepiglottic fold, larynx, and pyriform fossa.

Fig. 16. Postoperative view of Figure 15.

ative procedure, the final results of endolaryngeal surgery are largely dependent upon the selection of the case and the thoroughness of the surgical removal. Three types of lesions are recognized when endolaryngeal surgery is considered. The earliest malignancies are those cordal lesions limited to the anterior and middle thirds of the vocal cords in which the growth is practically a surface lesion and consequently limited to the cells above the basilar membrane. The symptoms produced by such a lesion are, indeed, slight and only mild voice changes are noted. The operative procedure involves the resection of the growth with a free margin of uninvolved tissue on all sides. Preservation of the vocal process which is possible only in early malignancies, is responsible for a good voice, when in due course of time, a pseudocord is formed. In the second group are those in which the early lesion has extended with increased cell proliferation, induration, tumor size, and lagging of the vocal cord, but without fixation. The lagging indicates that cell proliferation and growth have extended sufficiently to involve the muscle fibers but with no involvement of the joint. Complete extirpation of the cord followed by coagulation of the base is the only procedure that will give satisfactory results. In addition to this, postoperative radiation is indicated. These patients are kept under observation for an extended period of time. Any recurrence will necessitate a second operative procedure, the type of operation depending upon the extent of the recurrence. A squamous cell carcinoma in a physician required three intralaryngeal operations to affect an apparent cure.

When Dr. B. first consulted us, mirror laryngoscopy showed an early carcinoma on the anterior third of the left vocal cord. By means of suspension laryngoscopy, the left vocal cord was extirpated from the vocal process to the anterior commissure and the base was coagulated. The pathologist reported a squamous cell carcinoma grade 2. At the end of 4 months there was evidence at the site of the operation of a small granuloma or else a recurrence of the original lesion. Surgical removal was accomplished with a more extensive electrocoagulation of the base. He was kept under close observation, and at the end of 10 months another small growth appeared in the region of the anterior third of the left cord. This was again removed and cauterized. The pathologist reported a squamous cell carcinoma at the time of the second and third operations. Four years have elapsed since the last operation and only a hoarse voice produced by a pseudocord remains as evidence of former trouble.

To group 3 belong the border line cases (Fig. 13), in which the extent of the lesion is such as to make the success of endolaryngeal surgery doubtful. The lesions in these cases are best removed through laryngofissure or preferably by laryngectomy. Frequently a malignant lesion of the larynx is more extensive than the surface lesion would at first indicate. In these cases, there can be no compromise and radical surgery is indicated. We have always used the one stage operation and in the past 3 years, we have found that a straight midline incision has given even better results than the old T incision formerly used. The straight incision is particularly of value in patients with thin necks. Retraction is easily accomplished and the larynx is dissected out with little difficulty. An advantage is that it affords greater support in the reinforcement of the suture line in the plastic surgery performed on the hypopharynx. We have obtained primary healing in the plastic repair of

the hypopharynx in many cases since using this technique. Proper selection of cases for laryngectomy gives good results and grateful patients.

The complaint of a sensation of fullness or consciousness of the lower pharynx should never be dismissed without a careful examination, as malignant growths of the hypopharynx, pyriform fossa, and mouth of esophagus (Fig. 14) give little warning of their presence until the lesion is far advanced. Suspension laryngoscopy offers an excellent approach to these new-growths, but, unfortunately, in the majority of cases, little can be done from the standpoint of surgery.

One case of supraglottic tumor with partial attachment in the pyriform fossa is illustrated (Fig. 15). Dissection with complete removal was secured (Fig. 16), and the patient is well without recurrence after a period of 3½ years. This represents an unusually successful result because most malignant tumors of the hypopharynx are inoperable long before a surgeon is consulted. The transhyoid and lateral pharyngotomy as advocated by Trotter is the best surgical approach to be used in treatment of malignancies of the hypopharynx. The advent of radiation with its enormous possibilities and promises, offers more hope to these unfortunate individuals. Martin has reported excellent results obtained by radiation in laryngeal and hypopharyngeal growths. The one most important factor in the treatment of all these conditions is early diagnosis. In cordal lesions, hoarseness is an early warning signal. Hoarseness accompanying lesions of the false cords, aryepiglottic folds, and rim of the glottis is not an early symptom. Lesions of the hypopharynx give little warning until far advanced. Malignancies of the larynx could be cured more frequently if the public were conscious of the dangers attending prolonged hoarseness.

While the black and white illustrations are of considerable interest, the exact reproduction of true colors existing within the normal and diseased larynx is the ultimate goal of motion picture photography. In the past 2 years, success has attended my efforts directed at color photography so that today fully 600 feet of film showing pathological lesions are available in normal colors. The recent production of a new color film promises to relegate to antiquity the former method employed in color photography. Now more experimentation and time will be necessary to collect a sufficient number of cases to warrant presentation.

Clinical experience is the method of choice in the teaching of clinical pathology of the larynx, and over a period of time all variety of cases can be observed. A rapid review of all such cases is afforded in a few minutes by motion pictures. While the laryngologist has ample opportunity to observe these various lesions in his practice, it is my ardent hope that these pictures will serve to stimulate the interest of the general surgeon in laryngeal conditions and to enhance the possibilities of an earlier diagnosis, particularly in malignant conditions. Early diagnosis is imperative if one is to be successful in the fight against carcinoma of the larynx.

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IRIDOCORNEOSCLERECTOMY FOR GLAUCOMA[1]

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A TECHNIQUE for iridocorneosclerectomy is described which possibly combines the best features of the Lagrange iridosclerectomy, the Elliot trephine operation, and the Holth punch operation. The excision of tissue in the angles of the wound and the complete closure of the conjunctival wound over a bleb of salt solution usually produce a broad, evenly diffused, filtering cicatrix. The procedure seems to be indicated when a filtering operation is necessary; that is, in cases of chronic primary non-congestive glaucoma; in acute congestive glaucoma; in cases of secondary glaucoma, and in glaucoma following cataract extraction. Obviously, cases with few secondary changes in the iris, early cases with minor field changes, and those in which miotics lower tension, react most favorably.

The contra-indications for iridocorneosclerectomy are the presence of advanced arteriosclerosis and unusually high blood pressure, new vessels on the iris, buphthalmos, and microphthalmos.

The technique is as follows: After aseptic preparation and injection of the eyelids, inject subconjunctivally, over each rectus muscle, 1 per cent procaine with 3 minims of a solution of adrenalin (1:1000) to each dram of procaine solution. In the operations performed recently, the ciliary ganglion was injected with 1 cubic centimeter of procaine adrenalin solution. The conjunctiva above the cornea is ballooned with the adrenalin novocain solution. With Stevens' scissors, a slightly curved incision 15 millimeters in length, and 10 millimeters from the limbus, is made through the conjunctiva to the sclera with the concavity toward the cornea; this flap is dissected from the underlying sclera down to the cornea. The extremities of the incision should be kept at least 8 millimeters from the cornea. The flap is folded back over the cornea and dissection is done with a flat, sharp spatula with a rounded end, gently into the layers of the cornea with a side to side movement. With a blunt spatula placed between the layers thus dissected, and with the conjunctival flap restored to its original position, the point of the spatula should extend 1.5 millimeters into the cornea. The eye is directed and held downward with a fixation forceps, and an incision is made with a broad, hollow ground keratome. The incision is started in the sclera 1.5 millimeters above the limbus and is extended into the anterior chamber until a wound approximately 4 millimeters long is obtained. If the anterior chamber is shallow, the incision may be made with a short narrow, curved Graefe knife. While the keratome is being withdrawn, care is exercised to prevent the iris from prolapsing into the wound. If prolapse occurs, and it cannot be replaced readily, exclude the iris with a spatula while the punch is being used. Stevens' scissors are used to extend the angles of the scleral wound for a distance of 0.5 to 1.0 millimeter, which makes an incision approximately 5 millimeters long. The cuts should be parallel to the limbus and should allow the introduction of the special scleral punch into the angles of the wound. With the punch, the sclera and cornea (Fig. 1A) are clipped as deeply within each angle as possible; the remaining lip of sclera and cornea is then clipped, a serrated edge (Fig. 1B) being left. The wound should extend 0.5 to 0.7 millimeter into the cornea.

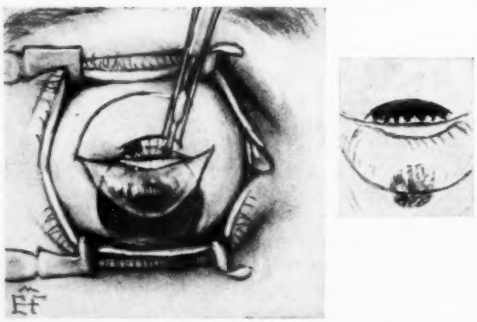

Fig 1. A, left. Removal of the scleral and part of the corneal lip with special punch. B, Appearance of the wound uncompleted.

A broad two cut glaucoma iridectomy is now performed. After the first cut, the iris is torn from the ciliary body by traction forward and toward the uncut side. In selected cases of chronic non-congestive glaucoma, a peripheral iridotomy or iridectomy may be performed.

The conjunctival wound is closed with an over and over running catgut suture (No. 0000 plain). After the suture is drawn tight and the wound edges, except at the extremities, are crushed with forceps, a grooved spatula is inserted in one angle; an anterior chamber irrigator filled with half normal physiological saline solution is placed in the opposite angle, and all blood and fibrin are washed from under the flap. Sufficient solution should remain under the flap to balloon it forward and to restore the anterior chamber if possible. The extremities of the wound are now crushed and closed with forceps. Metaphen ointment (1:2500) is applied over the inner canthus, and 1 drop of 3 per cent atropine is instilled.

Since the ends of the suture have been cut close to the conjunctiva, a ring or a guild mask may be applied over the wound without a dressing. The patient should remain in bed with his head elevated. In from 24 to 48 hours after operation, gentle massage of the eyeball is begun; this is repeated 3 times each day. On the day following operation, the

[1]Abstract of paper presented before the Clinical Congress of the American College of Surgeons, San Francisco, October 28—November 1, 1935.
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patient is allowed out of bed and general routine care is administered. Atropine is instilled to keep the iris well dilated and metaphen solution (1:2500) is continued until the congestion which is present subsides.

Although the trephine wound may filter, the conjunctival covering may become so thin that rupture and infection occasionally will occur. Crushing the edges of the conjunctival wound, combined with suturing, produces complete closure which permits early, firm massage. Ballooning of the conjunctiva and omission of the dressing also aids in maintaining drainage. Complete closure of the wound reduces the danger of exogenous infection to a minimum and leads to early reformation of the anterior chamber which encourages normal drainage of the intra-ocular fluids and restoration of normal intra-ocular relations.

MALIGNANCY OF THE UPPER RESPIRATORY TRACT AND ADJACENT STRUCTURES[1]

Selection of Treatment

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SELECTION of the most effective therapeutic agent for the treatment of malignant tumors of the upper respiratory and alimentary tracts is especially important because of the activity of the majority of these neoplasms. The institution of improper primary treatment is often responsible for a fatal termination later. Only a comparatively small group of therapeutic agents and procedures are worthy of consideration in the treatment of these tumors. Among these are straight surgical procedures, the actual cautery, escharotics, electrocoagulation, radium, and roentgenotherapy. Each of these possesses certain features which may be of decided value in a given case, but which may be of little value or even harmful, in another case. Choice of the proper agent or procedure is accordingly just as essential as is choice of the correct method of administration. The chief factors influencing such selection are the nature, situation, and extent of the lesion; whether or not it has been treated previously; and the age and general condition of the patient. Physicians are not entirely in agreement concerning the importance of these various factors, and conclusions based solely on personal experience at the Mayo Clinic are here presented.

In general, it may be said that treatment for neoplasms of the upper respiratory and alimentary tracts should never be instituted until a diagnosis has been established. This will frequently necessitate biopsy. The majority of malignant tumors of this region are squamous cell epitheliomas, and metastasis is prone to occur early. It accordingly is necessary to treat the regional lymphatics actively, as well as to treat the primary growth. Wherever possible, surgical removal of the lymph nodes is most effective in preventing metastasis; in other cases, because of the extreme activity of the lesion, its situation, and the questionable prognosis, irradiation is preferable. Tumors that are situated in regions which are readily accessible may be excised or destroyed with the actual cautery or diathermy. Those that are situated in regions such as the nasopharynx or hypopharynx, difficult to reach, should be coagulated with diathermy or treated with radium or roentgen rays. Carcinomas of mixed tumor type, which are encapsulated, should be excised. Lesions previously treated, especially those which have been treated with irradiation, must be dealt with more radically than they were before, and the prognosis in these cases is, as a rule, less satisfactory.

Among the most important considerations in the selection of treatment for malignant lesions in this region are the nature of the tumor and its activity. While Broders' classification of malignant growths is not necessarily a criterion of their radiosensitivity, it is of considerable value in determining the type of treatment advisable in a given case and in anticipating the prognosis. Malignant lesions that have been graded 1, 2, or 3, if surgical, should be excised or destroyed with the actual cautery or electrocoagulation, and the regional lymphatic structures should be removed subsequently. This same procedure usually is carried out in the case of well localized epitheliomas that have been graded 4, and intensive irradiation is applied after operation. However, more reliance is placed on the radium and the roentgen rays. In the treatment of extensive lesions of moderate activity, irradiation can often be used advantageously to supplement surgical measures. Likewise, in dealing with highly malignant tumors, irradiation, which constitutes the major part of the treatment, may be applied to advantage following removal or destruction of all, or a portion, of the growth with electrocoagulation.

Because of the limited time, treatment of carcinoma of the lips will not be considered in this paper. However, the malignant lesions which develop on the inner surface of the cheeks correspond in their nature, activity, and clinical behavior to those which involve the lips, and the therapeutic indications are similar in the 2 groups. With few exceptions, the buccal lesions are squamous cell epitheliomas of slightly greater activity than those on the lip. Most of the buccal tumors are graded 2 or 3, according to Broders'classification. An occasional adenocarcinoma is encountered. Well localized growths situated on the anterior portion of the buccal surface may be excised with the cutting cautery, but destruc-

[1]Presented before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

tion *in situ* with electrocoagulation is much more readily accomplished and offers an equally good prognosis. The lymph nodes in the submental, submaxillary, and upper jugular triangle on the same side as the lesion should be removed routinely unless the growth is active or has received previous treatment, in which event bilateral dissection is advisable. If involvement of any of the lymph nodes is demonstrated at operation, block dissection of the lymph nodes on the affected side should be done. When the primary lesion is extensive and perforates the cheek, excision of the full thickness of this structure, together with thorough electrocoagulation of any attachment to the jaws, is at times necessary. This leaves a large defect which extends through the cheek into the mouth, but because of the possibility of recurrence, no attempt at closure of the opening should be made for from 6 months to a year, depending on the extent and activity of the growth.

Malignant tumors of the jaws consist of epitheliomas, sarcomas of different types, and adamantinomas. The epitheliomas vary in their activity from low grade papillary growths to fulminating sarcoma-like tumors that become very large locally and metastasize extensively within the course of a few months. The clinical appearance presented by these lesions of varying activity is rather distinctive, but an accurate description of this difference is difficult. In general, the softer, more friable, and more vascular the lesion, the higher the grade of malignancy. It is now generally conceded that destruction of carcinomas of the jaws with the actual cautery or electrocoagulation offers a much better prognosis than does resection. Since the technique is much simpler, diathermy has very largely supplanted the cautery in the treatment of these tumors. Radon points which are often used as a supplementary measure, are inserted directly into the coagulated region immediately following diathermy. This is especially helpful in the case of highly malignant growths. The regional lymphatics in such cases present much the same problems as in cases of epithelioma of the cheek; although, when the lesion is confined to the alveolar process alone, metastasis is much less likely to occur than if the adjacent soft tissues of the cheek or floor of the mouth are involved. The treatment of sarcomas is the same as that of the rapidly growing epitheliomas; intensive external irradiation is always used in addition to local measures in the treatment of the active group of these tumors.

Adamantinomas should be dealt with in the same manner as the low grade epitheliomas. Only local measures are necessary, as metastasis rarely occurs. Adamantinomas or adamantine epitheliomas are multilocular cystic tumors, which supposedly develop from remnants of the primitive dental enamel organ. They occur most commonly in the molar region of the mandible. They are mildly malignant locally, being analogous in this respect to the basal cell epitheliomas of the skin. They rarely metastasize, but may become active and attain huge proportions; at times, they even invade the skull and cause death. Adamantinomas that are not too extensive are best treated with diathermy or resection. With the larger tumors of this type, marked palliation may be obtained by drainage of the cysts, followed by insertion of radium and external irradiation.

Of 187 patients who had malignant tumors of the lower jaw and who were treated at the Mayo Clinic as outlined previously, 151 were traced. Of these patients 59.6 per cent lived 5 years or more after treatment.

Malignant growths which arise primarily from the upper jaw should be distinguished carefully from those which develop in the maxillary sinus and invade the alveolus and hard palate secondarily. Those which arise in the maxillary sinus usually are much more highly malignant than are those which originate in the jaw. Treatment of tumors of the maxillary sinus is much the same as the treatment of carcinoma of the jaw, except that the more highly malignant tumors which are usual in this situation, necessitate greater reliance on radium and roentgenotherapy than on electrocoagulation. A group of 154 patients with malignant tumors of the upper jaw and palate were treated at the clinic. One hundred eighteen of these patients were traced and 74 per cent of those who were traced were alive 5 years or more following this treatment.

Another group of tumors to be considered in this connection are the adenocarcinomas of mixed tumor type, which frequently occur in the palate. They differ from most of the other malignant neoplasms of the mouth and throat in that they are encapsulated, grow slowly, and do not metastasize unless activated by trauma or incomplete removal. They can usually be dissected out with the capsule intact. Following removal of such a tumor, a smooth, concave excavation is found in the bony palate; this is the result of pressure absorption.

Most of the malignant tumors of the body of the tongue and floor of the mouth are active squamous cell epitheliomas. They are, as a rule, easily recognized clinically. Whenever there is difficulty in this regard, biopsy should not be

delayed. This is far preferable to prolonged observation. A considerable proportion of patients with carcinoma of the tongue also present a positive serological test for syphilis. This frequently leads to a great deal of delay in diagnosis and treatment, as antisyphilitic measures are usually instituted and the patient is kept under observation for a prolonged period, in spite of progression of the neoplasm. By the time the conclusion is obvious that syphilis is not responsible for the tumor, the growth is often so hopelessly advanced that treatment is of no avail.

Malignant lesions of the tongue, if operable, may be excised with the scalpel or with some form of cautery knife. Often, radon seeds are inserted into the open wound prior to suturing. Closure of the wound following excision with the scalpel or with the cutting cautery is usually followed by primary healing. If the growth in the tongue is extensive, or if the floor of the mouth is involved, surgical diathermy is, as a rule, preferable to excision. The former procedure is bloodless, although there is a possibility of secondary hemorrhage on separation of the slough. Radon seeds are frequently used subsequent to destruction by diathermy, especially in the case of active lesions. Carcinoma of the tongue which is not surgical is best treated with gold radon seeds or platinum points containing radium element. Some of these lesions respond remarkably well to this type of treatment, and in some instances growths that had appeared to be beyond help with any therapeutic measures have been cured. Besides local treatment of these extensive growths, external irradiation is applied over the regional lymph nodes. In cases in which treatment is surgical, bilateral dissection of the submental and submaxillary lymph nodes and block dissection of the lymph nodes on the side involved, should be carried out as soon as the condition of the wound in the tongue permits and the patient's general condition warrants. If the patient is not a good surgical risk, more conservative dissection of the lymph nodes should be carried out. Radium is at times implanted into the wound at operation, and intensive external irradiation is administered subsequently when extension to the lymph nodes is demonstrated. A total of 162 patients with epithelioma of the tongue were treated at the clinic. Of the 156 who were traced, 37.2 per cent were living 5 years after operation. Of 74 patients in this group, who had no evidence of involvement of the lymph nodes, 51.4 per cent were living 5 years or more after operation.

Tumors of the pharynx and tonsils are, in general, highly malignant epitheliomas and lymphosarcomas. A small percentage are mixed tumors, sarcomas of special type, and epitheliomas which have a low grade of malignancy. Any of these neoplasms may be primary in the tonsils or in the adjacent tissues. It is often difficult to determine definitely regarding the primary site of origin. However, the treatment is much the same for either group. The inactive epitheliomas should be destroyed with diathermy, and radon seeds should be immediately inserted into the coagulated region. The regional lymph nodes then should be removed and the procedure supplemented by surface irradiation. In the case of active lesions, radon seeds are sometimes implanted in the affected nodes, directly through the intact skin or following surgical exposure of such lymph nodes. Highly malignant epitheliomas and lymphosarcomas are most satisfactorily treated with radium inserted directly into the growth or applied over its surface; radium packs or deep roentgenotherapy may be used externally.

Many of these patients do very well, particularly if the lymphosarcomas are of a fulminating type and have been present for only a few weeks. Fibrosarcomas may be treated in the same manner, although the response to treatment is, as a rule, less satisfactory than in the lymphosarcomas. Mixed tumors in this region are entirely different from the growths just mentioned. They are encapsulated, grow slowly, and do not ulcerate or infiltrate the surrounding tissues until late in the course of the disease. Metastasis does not occur until their retaining capsule has been ruptured. Such tumors should be removed surgically, either through the mouth or by external incision. Preliminary ligation of the external carotid artery on the same side renders the operation much easier and safer. Treatment of the lymph nodes is not necessary and the prognosis is good. Radium is placed directly into the wound if there is any question regarding the clean removal of the growth, and radium or deep roentgenotherapy later is applied externally. If infiltration of the surrounding tissues has occurred, radon seeds and external irradiation will accomplish more than will surgical procedures.

The outlook in treatment of malignant tumors of the pharynx and tonsil varies with the type of neoplasm. Of 44 patients who were traced at the clinic following such therapeutic measures, 57.9 per cent were living 5 years or more after the treatment. Twenty-nine of the patients in this group had had adenocarcinoma of mixed tumor type, and 93.5 per cent of these were well; whereas, only 26.5 per cent of the 9 patients who had squamous cell epitheliomas and 54.5 per cent

of 6 patients who had lymphosarcomas lived for 5 years after the operation.

The majority of malignant tumors presenting in the nasal fossæ are the result of extension of neoplasms which originate in the maxillary sinuses, ethmoid cells, and nasopharynx. However, a small group of malignant lesions develop primarily in the nasal fossæ. Most commonly encountered are squamous cell epitheliomas, adenocarcinomas, lymphosarcomas, and fibrosarcomas. Many of these are highly malignant. In the selection of treatment, the nature of the tumor, its situation and extent, and the general condition of the patient must be taken into consideration. Electrocoagulation and radium are most useful in this regard. They may be applied directly through the nasal meatus or following lateral rhinotomy. Since the Moure operation, i.e., lateral rhinotomy, gives easy access and a good view of the tumor, and leaves a comparatively inconspicuous scar, it is usually preferable, unless the growth is small and situated anteriorly. Thorough electrocoagulation can be carried out and radium points can be implanted as a supplementary measure. When both the antrum and the nasal fossa are involved, the Denker operation furnishes a more satisfactory approach. While, as a rule, there is little immediate reaction to even extensive electrocoagulation within the nasal fossa, great care must be exercised in the destruction of tumors situated high up, because of the possibility of burning through the cribriform plate with production of meningitis. In a recent case in which an adenocarcinoma originated in the ethmoid cells and involved the frontal sinus and upper part of the nasal fossa secondarily, the tumor was approached through a semilunar incision along the inner border of the orbit. The encapsulated upper portion of the tumor had produced pressure absorption of the posterior wall of the frontal sinus and exposed a portion of the dura which was approximately 1.5 centimeters in diameter. When the tumor in the nose is extensive and highly malignant, implantation of radium points, together with radium packs or roentgenotherapy, will usually offer marked palliation. However, active neoplasms that fill a large part of the nasal fossa and appear too extensive for operation, often will be found attached by only a small pedicle, and careful electrocoagulation and wide destruction of the attachment of this pedicle will result in a cure. In the treatment of this group of tumors as well as those of practically all other portions of the upper part of the respiratory tract, with the exception of the larynx, intratracheal anesthesia is of decided advantage.

Malignant tumors of the nasopharynx occur more frequently than is generally supposed. The majority of these tumors are highly active squamous cell epitheliomas and lymphosarcomas. While they may develop in any part of the nasopharynx, they most commonly originate in, or adjacent to, the fossa of Rosenmueller. Here, they are in close proximity to a number of important structures and, through involvement of these, produce a characteristic symptom complex.

Because of the activity of those tumors, the difficulty of accurately determining their extent, their tendency to metastasize early, and their inaccessibility, irradiation is the treatment of choice. Roentgenotherapy or radium packs are used externally over the head and neck, and radium tubes on a pliable applicator are placed directly in contact with the tumor in the nasopharynx. Operation is rarely indicated in this group of neoplasms, either for removal of the primary lesion or the regional lymphatics. Palliation only is likely to be obtained, although the growth can often be held in check and the patient kept in comparative comfort for several years. In a few instances, complete arrest of the disease for 6 and 7 years has resulted.

The malignant tumors of the base of the tongue and hypopharynx are chiefly highly malignant squamous cell epitheliomas, lymphosarcomas, and adenocarcinomas. Irradiation is the treatment of choice in the majority of these cases, for the same reasons mentioned in connection with neoplasms of the nasopharynx. As a rule, implantation of radon or radium element points in the primary lesion is preferable to the direct application of radium tubes to its surface, because of greater accuracy and efficiency of the former. Infrequently, tumors on the base of the tongue are encountered sufficiently early to justify electrocoagulation following exposure with modified laryngeal suspension. This treatment is supplemented with implantation of radium points, and if the degree of malignancy is not too great, block dissection of the lymphatic structures on the same side of the neck is advisable. A number of 5 year and even 10 year cures have been secured in this group, with both the irradiation and surgical measures which have been outlined.

The great majority of malignant tumors of the larynx are squamous cell epitheliomas. In general, they are best treated with radical operation, as only through an open operation can the majority of them be clearly visualized and rendered accessible. At times, however, the nature, activity, situation, and extent of the lesion, or the age and general condition of the patient, render radi-

cal surgical measures inadvisable. Growths situated in the supraglottic region, especially those springing from the epiglottis, are commonly inactive in type, and at times may be destroyed readily with diathermy by using direct, indirect, or suspension laryngoscopy. The prognosis in these cases is good. Pharyngotomy, however, is the most universally satisfactory method of dealing with the majority of the lesions in this region. Tumors which involve the epiglottis and extend posteriorly along the aryepiglottic folds and laterally into the pyriform fossæ, are better taken care of through a subhyoid approach by making a transverse incision at the base of the tongue and drawing the epiglottis out into the wound. On the other hand, when there is limited involvement of one aryepiglottic fold with extension onto its outer aspect, or when there is involvement of the epiglottis and base of the tongue, lateral pharyngotomy is preferable, after removal of the thyroid ala and, if necessary, a portion of the hyoid bone. In cases in which the growths are extensive, preliminary tracheotomy greatly lessens the risk of pharyngotomy, as in other laryngeal procedures.

Laryngofissure or thyrotomy is indicated in cases of laryngeal carcinoma in which the tumor is inactive and freely movable, but if the tumor is active, it must be found very early and be well localized. After the larynx is opened in or adjacent to the midline, the lesion is destroyed with electrocoagulation, or is excised and the wound cauterized. The results as regards control of the malignant process are extremely satisfactory with laryngofissure in properly selected cases. Of 34 patients who have been traced following removal of laryngeal carcinoma in this manner at the clinic, 28 (82.3 per cent) were living and well 5 years after the operation.

When the malignant process involves both sides of the larynx or extends to the arytenoid cartilages on one or both sides, especially if it is active or if there is fixation, complete removal of the larynx alone offers a reasonable chance of controlling the disease. The operation has been perfected during the course of years until at the present the mortality following it is very low. It is best carried out under cervical block anesthesia. While it may be done in a single stage, preliminary tracheotomy lessens the risk. Even though most laryngeal carcinomas are highly malignant, the operation will result in cure in a large percentage of cases, provided the tumor has not spread beyond the larynx. Seventy-three patients were traced following laryngectomy at the clinic, and 41 (56.1 per cent) of them were alive and well 5 years after the operation. These patients are routinely provided with a simple mechanical means of voice production, and most of them are able to resume their original calling.

ORBITAL ABSCESS WITH COMPLETE RECOVERY[1]

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THE general impression that the oculist meets only with the simple, easily handled case and that when a serious complication is met he refers the patient elsewhere, is erroneous. This misconception is probably due to the fact that we are inclined not to report cases of a grave nature, but more likely to lay stress on interesting operations and brilliant results.

After surveying the operative field, I concluded that, inasmuch as cataract operations with their flaps and bridges, muscle operations with their tucks and recessions, operations for glaucoma with trephine, deep iridectomies, iridotases, and every means of establishing drainage, had all been discussed and rediscussed, some other topic would be of greater interest. My investigation turned to other channels; my first thought was that I might discuss postoperative complications, unexpected drug reactions, or infections of a secondary nature, but finally I recalled that my most anxious moments had been spent over abscess of the orbit and surrounding tissues and so chose this for my topic.

Orbital inflammation, cellulitis, phlegmon—of cavernous, cerebral, and systemic involvement—easily can be classed as the most severe conditions with which the oculist has to cope. They require prompt and constant attention; treatment necessary to ameliorate the attending symptoms as well as the disease, and all directed toward the etiological factor. Literature teems with the reports of cases of ocular cavernous and brain complications, most of which had unfavorable endings; few are reported with complete recovery and normal vision. I have found the condition very hard to deal with, and for this reason I hope that my study will stimulate others to report not only the unfavorable but the favorable results.

The etiological factors are similar to those of infections in any other part of the body, but when we bear in mind the close proximity of the orbit to the vital structures of the head, we readily realize the added importance of being able to determine the causative factor. The nasal sinuses are the ones most frequently involved. Infections may be present in the surrounding tissue; for instance, there may be operative complications, meibomian cysts may be present, or there may be encapsulated cysts. The least common causative factor is metastasis. It should be borne in mind that in treating these patients every effort should be made to determine the cause of the trouble.

Symptoms of cellulitis of the orbit are, first, a feeling of discomfort with little or no visible inflammation; soon the lids become edematous with the conjunctiva chemotic; mobility of the globe is impeded and proptosis begins, vision is blurred in proportion to the pressure and pulling on the optic nerve. At this time there is a slight engorgement of retinal veins and possibly a swollen disc. Severity of symptoms increases rapidly, with pain, rise in temperature, and possibly cerebral disturbance. Perhaps the most important diagnostic point is the amount of retinal vein engorgement; when this is great, cavernous sinus involvement is feared; when slight, the inflammation is confined to the orbital walls.

Under constant treatment the infection may be arrested and the globe slowly may return to normal position. When suppuration occurs, the edematous tissue reddens and the conjunctiva changes from a pale chemosis to an angry red, which indicates immediate surgical interference. Incisions should be made fearlessly within the lid margins if possible; if this is impossible, then through the lids at the points showing the greater tension. The knife is carried deeply into the orbital cavity being held close to the wall and between the muscle attachments. More than one point of drainage is usually necessary, possibly a narrow wick drainage being inserted deeply in the wound and changed as the condition indicates. The moment drainage is free, recovery is rapid. The cornea is in great danger and should be watched carefully, for I know of no ocular condition that calls for more gentle care. Only when the lids become flaccid, can we begin to lessen our vigilance. Let me again repeat the warning of prompt and early incision before rupture has occurred. Constant attendance, changing hot dressings, sustaining and symptomatic treatment, all are most important.

I have probably had my share of inflammatory conditions of the orbit in my clinical work and will mention them briefly in connection with other cases gleaned from the literature. A few of these had favorable endings, but in more the results were unfavorable, some even fatal. From my private records I have selected 3 cases of the most severe type in which the patients made a

[1]This paper is primarily intended to report orbital phlegmon with complete recovery, but to perfect the review of so serious a condition, I have included from literature, cases showing every phase of the disease, namely: favorable recovery, unfavorable recovery, and fatal termination. Presented before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

perfect recovery without deformity or lowering of the vision. All had severe general reactions, high temperatures, and malaise, but the blood cultures were positive in but one.

REPORT OF MY THREE CASES

CASE 1. 1915. Female, aged 32 years, married. Following a severe nasal infection patient noticed irritation in the inner canthus of the left eye, which rapidly increased. I saw her 2 days after onset when the globe was moderately proptosed; lids, chemotic; conjunctiva, edematous. Vision was blurred and somewhat lowered. Treatment was directed toward the nasal condition. All cavities proved negative but the ethmoid. Treatment at first was by means of suction and pack, but this condition steadily became worse and the temperature was over 101 degrees. The ethmoids were exenterated without effect. The usual local applications were used and care was taken to protect the globe. After 4 days an incision was made deep into the orbital cavity at the inner canthus; free drainage to pus was thus established. The staphylococcus was found. Symptoms began to abate and temperature dropped to normal. Recovery was uneventful with vision of 20–20. Duration of illness about 3 weeks.

CASE 2. Male, aged 50, married. Patient was a very nervous individual. The left upper lid had been swollen several days before I saw him. I found a badly inflamed eye, marked edema, swollen lids which were very painful. Temperature was 100 degrees Fahrenheit. He was unable to get satisfactory vision because of the swollen condition of the lids and conjunctiva. An abscess of the upper lid was incised and cleansed. Constant local and symptomatic treatment was instituted. On the following day the symptoms were more marked: temperature was 102 degrees and a septic condition was very evident. He was sent to the hospital. We made 3 deep orbital incisions. Pus appeared in all three and from this time, symptoms began to abate. Three weeks elapsed; the cornea remained clear and recovery was perfect. Vision was 20–20.

CASE 3. Female, aged 29 years, married. A small tumor of 3 or 4 months' duration was removed. It was located on the left upper lid, just below the brow. The tumor was about the size of a pea, apparently encapsulated, lipoma-like in character, with cystic degeneration. No laboratory diagnosis was made, as to all appearances it was a simple cystic tumor. The usual procedure was followed and the patient was sent home. The following morning she came in with a septic condition and temperature of 103 degrees Fahrenheit. The stitches were removed and wound was cleansed. She was sent to the hospital, her temperature rose steadily to 105 degrees that evening. The first laboratory reports indicated possible tetanus, so an injection of antitetanus serum was given. Later in the evening laboratory analysis showed pure streptococcus infection, so vaccine for that was given. Going more fully into the etiology, the patient recalled that a small tumor followed a severe streptococcus throat infection about 6 months before. As drainage was present from the tumor site, no further drainage was made at the time, but moist dressings were constantly applied and symptomatic treatment instituted. Vaccine gradually increasing from 1 cubic centimeter was given at the low temperature wave. On the third day following admission, an erysipeloid condition began on the left side of face extending across the nose and finally involving both cheeks and brow. The globe proptosed, conjunctiva was edematous, but the cornea remained clear, although vision was blurred. Blood culture was positive for the streptococcus; white count at one time was 20,000. The patient's mind became confused and her condition was grave. Early on the third day, a deep orbital incision was made through the lids externally and pus appeared. Symptoms began to subside but increased again on the fifth day. An incision at inner canthus again elicited pus. A chill on the sixth day followed by rapid elevation of temperature called for a third incision. Following this procedure, the symptoms gradually subsided and the patient left the hospital after 4 weeks with no deformity, normal vision, and full ocular movement.

The etiological factor in this case was directly traceable to a septic streptococcus throat infection about 6 months previously. Patient distinctly recalled that the tumor began as a painful lump soon after, and the inference was that it became an encysted streptococcus sac.

Treatment in general was the same in the 3 cases: constant moist hot applications. Vaccine was used in Cases 2 and 3, but the first used only the hot applications, wick drainage, and symptomatic treatment; the condition being secondary to a nasal infection.

ORBITAL CONDITIONS WITH EXOPHTHALMOS

On my service at the Illinois Charitable Eye and Ear Infirmary over a period of many years, we have of course met many cases of greater or less severity. Some of the least severe have been orbital cellulitis or periostitis cases showing marked proptosis, edema, pain, retarded mobility of the globe, and disturbance of vision but, at no time, any of the most marked symptoms of suppuration. Under diligent treatment, both medicinal and local, the patients have recovered. In 2 cases I recall that the vision was greatly lowered and in 1 patient mobility of the globe lessened due to the long continued inflammation involving the ocular muscles.

We are seldom called upon to do exenterations. In fact, from the reports of the various large hospitals, 1, 2, or 3 eviscerations are as many as are done in 1 year.

Two orbital abscess cases with cavernous sinus involvement terminated fatally, one in an adult and the other in a child upon whom a muscle operation had been performed. This was in the early days of catgut tucks and unquestionably was due to that.

We have also had 2 cases of tumor in which the diagnosis was long in doubt. In one, a tumor mass was found to lie deeply to the outer and lower part of the orbit. A bioscopy proved it to be sarcoma. A tumor about 10 by 20 millimeters was removed with a small part of the maxillary bone. The globe returned to normal position and vision returned to 20–70, but the outward move-

ment was impeded, no doubt due to injury to the muscle during the rather extensive operation. Three years have elapsed with no recurrence.

We had a most interesting case of aneurism of the ophthalmic vein, extending deeply into the orbit and upward on the forehead to the hair line. Proptosis was extreme, becoming an unsightly popeye. Vision was reduced until the patient could move around only with the aid of the sense of touch. A deep incision was made to the nasal and frontal area, and the largely distended vessel was ligated. The patient showed marked improvement. A second ligation of branches terminated in a complete recovery and return of useful vision for this patient. The dangers of a carotid ligation caused us to consider the milder method which proved eminently satisfactory. The aneurism was caused by an automobile accident, the temporal walls as well as the orbital walls being fractured, but with not much displacement.

It is surprising how few cases involving the orbit we see in the large clinics and, in reviewing the literature, I conclude this is general.

While most of my patients were adults from 25 to 50 years of age, still the condition probably has occurred most often in children under 10 years of age. A series reported by Gamble,[1] of the Children's Memorial Hospital, indicated that the majority recover without operative interference and that, in a surprisingly high percentage, vision is only temporarily disturbed, no doubt due to the greater resistance in childhood.

The danger of orbital infections is increased because the infection probably begins under the very thin periosteum which is firmly attached to the sutures. Infection may extend not only into the orbital contents, but also directly to the more dangerous area. I am satisfied that recovery in the 3 principal cases reported, was due to early and extensive drainage; I can therefore earnestly urge surgical interference at the earliest moment the diagnosis is definitely determined. Because the upper portion of the orbit is very thin and of course lies close to the brain and cavernous sinus, it should be avoided as much as possible in making the deep incisions. So I repeat, confine the puncture to the internal and external angles, through the conjunctiva if possible, but if swelling is too great, the puncture must be made through the skin at the orbital margin. This was necessary in 1 case, but in the 2 others the conjunctival incision was possible.

OTHER CASE REPORTS

Case 1. Dr. O. B. Nugent, Chicago, Illinois. Retrobulbar abscess with complete recovery. Male, aged 37 years. Patient had had marked swelling of left eye for 10 days; lids could be opened only by force. Hot applications were used. An incision was made through the upper lid at junction of the middle and outer thirds. Much pus was obtained and drain was placed. Discharge was profuse for about 3 days, after which it gradually subsided. Wound healed in about 10 days. Swelling and edema did not entirely disappear for about 6 weeks. Vision returned to normal.

Case 2. Dr. Frank A. Plum, Honolulu. Northwest Med., 1931, Aug. Bilateral orbital abscesses, simulating cavernous sinus thrombosis. Trouble started from pimples about the nose; both eyes were involved. Symptoms of cellulitis were severe and simulated cavernous sinus. Both orbital cavities were drained, also the frontal sinuses. Vision was normal in left eye, nil in right.

Case 3. Dr. W. E. Scott-Moncreiff. Canadian M. J., 1930, Aug. Dacryocystitis leading to orbital phlegmon, optic neuritis and atrophy. Female, aged 45 years, had an orbital abscess extending from the lachrymal sac. There was severe ocular disturbance. Symptoms gradually subsided after incision and later extirpation of the sac, but vision was lost, due to an embolism of the central artery. Temperature ranged to 100 degrees Fahrenheit.

Case 4. Dr. Paul L. Mahoney, Little Rock, Arkansas. Laryngoscope, 1932, Mar. Orbital abscess following submucous resection. Female, aged 23 years, complained of constant dull headache of several years' duration. There was a nasal obstruction and a septum resection was performed. Severe reaction followed with orbital abscess. Temperature rose to 103 degrees Fahrenheit, with edema, proptosis so extreme that loss of eye was feared. Incision at inner angle resulted in pus drainage and eventual recovery with full vision.

Case 5. Dr. Robert von der Heit, Chicago, Illinois, 1934, Sept. Male aged 40 years. Nasal origin, drainage from nose, antrum washings. Incisions were made in both upper and lower lids. Temperature at beginning was normal but increased to 102 degrees. Duration was 3 weeks. No incision was made in orbit, but drainage perforated connecting with antrum. No mention of eye involvement was made.

Case 6. Dr. E. K. Findlay, Chicago, Illinois, Illinois Charitable Eye & Ear Infirmary, 1934, Mar. Patient had orbital abscess. Drainage was established through incision in lids. He was improving when he left the hospital.

Case 7. Dr. A. M. Terson, Paris. Arch. d'opht., 1930, Mar., 181. Orbital phlegmon and its abortion. Advises use of colloidal salts of silver and surgery when necessary.

Case 8. Dr. M. Halphen, Paris. Arch. d'opht., 1931, Oct., 727. Orbital phlegmon complicating ethmoiditis. Exophthalmus was followed by bloody nasal discharge. X-ray examination was positive for ethmoid involvement. Operation disclosed orbital-nasal communication. Recovery was rapid.

Case 9. Canuyt, Weill, and Horning. Rev. d'oto-neuro-ophtalmol., 1930, June, 454. Suppurative frontal sinusitis opening into orbit. A frontal sinus infection communicating with orbit, with proptosis and diplopia, necessitated surgical interference with drainage through an incision in the upper part of the orbit cavity and lid. Recovery was slow, eye was deviated, and marked diplopia was present.

Case 10. Portmann, Teyssandier and Got, of Bordeaux. Rev. d'oto-neuro-ophtalmol., 1931, Aug., 355. Orbital abscess following frontal sinusitis. Osteomyelitis of the orbital margin had resulted from extension from the frontal sinus. Operation consisted in multiple incisions in the orbit and temple margins and removal of caries. Convalescence was long and difficult, with high temperature Imperfect recovery. The staphylococcus was isolated.

[1] Arch. Ophth., 1935, Oct., p. 483.

CASE 11. Rebattu and Proby, of Lyons. Lyons méd., 1933, July 2, 9. Fatal cerebral, following orbital, abscess. A supra-orbital abscess was incised and the antrum drained. A cerebral abscess developed causing death in 1 month.

CASE 12. Prevot and Ourgaud. Rev. d'oto-neuro-ophtalmol., 1929, Jan., 35. Maxillary sinusitis with orbital phlegmon. The antrum was washed after a tooth was extracted. Immediately there followed pain in the orbit. Infection developed. Drainage was established and patient finally recovered after repeated surgical interference. This case is a warning against using pressure in irrigating cavities; it also shows the close relation of the orbit and cavities.

CASE 13. J. Kubik, Elschnig's Clinic, Prague. Med. Klin., 1932, Aug. 5, 1097. Two cases of orbital abscess in nurslings following furuncles of scalps. Each showed osteomyelitis of the antrum. Recovery with vision saved.

CASE 14. Paul Pesme, of Bordeaux. Rev. de laryngol., 1929, Jan. 15, 27. Orbital, following alveolar, abscess. An alveolar abscess extended through the antrum to the orbit. Vision was lost.

CASE 15. M. Claes. Read at sixty-eighth annual meeting, Belgian Society of Ophthalmology. Arch. d'Opht., 1934, Dec., 802. Three observations on phlegmon of orbit. In the first case, a diphtheritic rhinitis, an orbital abscess was drained through lachrymal sac, with recovery. In the second case, a submucous resection infection was drained through orbital incision with recovery. In the third case, a wound of the eyelid, an orbital abscess developed with erysipelas, a cavernous sinus infection which had a fatal termination.

CASE 16. Rollet and Parthiot, of Lyons. Arch d'Opht., Mar., 1931, 226. Dentogenous maxillary sinusitis with orbital phlegmon. An orbital abscess followed an antrum infection. A Caldwell-Luc operation was done, the opening being continued into the orbital cavity. Patient recovered. This case illustrates the possibility of drainage without external incision.

CASE 17. P. Defoug. Arch. d'Opht., 1935, Mar., 214. Orbital phlegmon. Osteomyelitis of dental bulbs. The first patient had necrosis of the maxilla and the second a venous thrombosis of the orbit; both infants recovered.

CASE 18. B. Strandbygaard, of Sonderberg, Denmark. Ugesk. f. Læger, 1926, Apr. 15, 379. Two cases of orbital abscess. The first a boy, aged 11 years, had an abscess of the orbit, which was opened through the antrum. The second, a sister of 6 years, had a similar abscess, which drained several weeks. Both recovered.

CASE 19. L. Genet, Lyons. Arch. d'Opht., 1931, May, 379. Thrombophlebitis of orbit. Patient had a furuncle of the lower lip with extension to mouth, cavities, and left orbit. High temperature; symptoms receded then came a relapse with general glandular and lung involvement. At time report was made patient was living but condition was grave.

CASE 20. P. Moers, Tilemont, Belgium. Arch. d'Opht., 1930, Sept., 645. Reported at the Belgium Society of Ophthalmology. Orbital phlegmon and diathermy. Patient had a phlegmon of the orbit and face which was incised by diathermy knife. The case illustrates the advantage of this method in which coagulation lessens the danger of spread of infection.

CASE 21. Prof. DiMarzio, of Rome. Riv. oto-neuro-oftalmol., 1929, Nov-Dec., 544. Orbital complications of sinusitis. Two cases are reported, both with perfect recovery by early operation on sinuses and drainage of the orbit.

CASE 22. Costiniu and Bernea, of Bucharest. Ann. d. mal. de l'oreille, du larynx, 1927, July, 693. Bilateral orbital abscess. Three operations were performed: first, on the mastoid; second, on the lateral sinus; and third, both orbits were drained. Convalescence was slow.

CASE 23. Gaillard and Mounier-Kuhn, of Lyons. Ann. d'ocul., 1931, Sept., 752. Bilateral orbital complications in exacerbation of sinusitis. Patient had a sinus infection of dental origin with orbital involvement and cavernous sinus thrombophlebitis. Death occurred in 6 days. Infection was carried to the cavernous sinus by the nasal and superficial veins. Extensive operation was of no avail.

CASE 24. Tauferova-Karaskova (Brno). Fifth Czecho-Slovakian Congress of Ophthal. Prague, 1930. Ann. d'ocul., 1931, Nov., 943. Two cases of orbital phlegmon. In the first case, a metastatic infection of orbit in third week of enteric fever (Bacillus typhosus) was cured by vaccine and X-ray without incision. The second case, a streptococcus infection of the orbit, was cured by incision and polyvalent vaccine.

CASE 25. G. Luciano. Boll. d'ocul., 1928, Jan., 78. Ethmoidal empyema of orbital origin. Patient suffered pain in the orbit with occasional discharge of pus from the inner angle; dust in eye caused sudden inflammation and exophthalmos. At operation pus was found in the ethmoid and sphenoid. It was concluded that infection was of oculo-orbital origin, as there had been no nasal secretion.

CASE 26. Monte F. Meyer and Jerome C. Reling, of New Orleans. Arch. Ophth., 1935, Mar., 445. Orbital abscess following foreign body in orbit. Meningitis with recovery. A piece of wood perforated the orbit; it was removed on the sixth day. Orbit drained, but patient had marked meningitis, from which he recovered in about 2 months. Also reports a second case similar in that the spinal fluid was positive. Patient finally recovered after decompression and serum were used.

CLASSIFICATION OF CASES REPORTED

Visual acuity is so seldom mentioned in the case reports that it is impossible to classify from that standpoint; however, an imperfect classification may be of interest as determined in 33 cases:

	Cases
Recovery, saving globe or vision	15
Partial recovery, saving life but loss of globe	11
Fatal—loss of life	7

The etiological factors may be classified as follows:

	Cases
Nasal sinus and dental	20
Infections of surrounding tissues	7
Metastases	3
Orbital origin	3

Discussion

DR. RAYMOND J. NUTTINGS, Oakland: In opening the discussion I personally feel that Dr. Orcutt is to be congratulated for bringing this very timely and too often neglected subject to our attention. We all agree that early diagnosis with etiology is absolutely necessary; once this is established, active medical and surgical treatment is indicated immediately and, as we all know, by the time we see most of these cases, surgery is the one treatment par excellence in order to save not only vision but life itself.

We have been very fortunate in our office, in the Cowell Memorial Hospital at Berkeley and in the County Hospital in Oakland, that the eye man has not opened the orbit in any of our patients with one exception in the last 10 years, and personally, I have not opened one in 15 years. However, if our cases had been of the same type of infection as those treated by Dr. Orcutt, I would not have hesitated to open directly into the orbit. In my private practice, orbital cellulitis has fortunately been secondary to paranasal sinus infection. Of course the ear, nose, and throat man has had to share the responsibility and to co-operate with the oculist as each man must depend upon the other. Of the cases that I have seen, with the exception of 2 from so called styes and another from a small furuncle on the forehead, all have been secondary to paranasal disease. The interesting fact to me has been that the 3 cases mentioned all developed cavernous sinus thrombosis with a generalized septicemia. In these cases the blood cultures were positive, 2 staphylococcus and 2 streptococcus. All 3 died: 2 in young girls, around 6 years of age, and 1 in a young girl about 20. Personally, I have not seen 1 death where there was an orbital cellulitis as result of paranasal sinus disease although they have been reported.

I feel that we cannot overemphasize the importance of a complete and thorough rhinological examination when an orbital cellulitis is suspected, when not due to an external injury, and if at this time any positive or even suggestive signs and symptoms are found, immediate conservative or radical treatment is indicated at once depending of course upon the type of case.

The signs, symptoms, and complications of orbital cellulitis, Dr. Orcutt has very well covered and the only suggestion that I might emphasize at this time is that, when there are no visual, ophthalmological, or field changes, conservative treatment can be attempted, but when definite eye findings are present, the more radical, surgical treatment is indicated and at once. Many a patient has lost his vision and even his life because we have delayed surgical interference.

In order to save time, money, and worry, when there are so many patients these days who are only too glad to start a law suit, it is important to have a blood culture made immediately on all these patients, and if there is any suspected intracranial involvement, a lumbar puncture as well is in order. Such patients then cannot make the accusation that your treatment was the cause of septicemia or intracranial disease.

Most of the cases we have seen have been in children. When they were seen early, a good visual result was obtained. But unfortunately, as mentioned before, patients wait too long before they call the doctor; naturally it is in these that we get our bad results. No doubt this is one of the reasons why so many men get such a variety of results.

Dr. Orcutt is to be congratulated on his wonderful care in Case 3, especially with a positive blood culture. Unfortunately, my 3 patients seen in private practice all died. Autopsy revealed that all 3 had cavernous sinus thrombosis.

No doubt, another factor in the cause of poor results in some of these cases in which the trouble is secondary to the accessory sinuses, is that conservative treatment has been prolonged, or that there has been poor co-operation between the oculist and the rhinologist. Whether the nose man does an external ethmoidectomy or an intranasal operation, he must be thorough and in most cases he must open the orbit as well, so that drainage may be well established.

CASE 1. Boy "R," aged 12 years, went swimming April 14, 1933. April 16, he had stuffy left nostril and pain in left eye. April 17 he was seen by his physician who suspected sinusitis and gave him ephedrine nose drops and hot packs. April 18, he had a swollen eye, pain, exophthalmos, and poor vision. April 19, he was seen by me at his home. Diagnosis: orbital cellulitis and optic neuritis. Vision in left eye, was questionable. He was sent to the hospital immediately and blood culture was returned negative. He was seen by Dr. McClure, who made diagnosis of acute purulent left pansinusitis. X-ray examination was positive. Operation was performed by Dr. McClure, intranasal opening of ethmoid, radical external ethmoidectomy including opening into orbital cavity. A large amount of free pus was found in the orbital cavity; the ethmoids and sphenoids were filled with pus under pressure. A rubber draining tube was introduced. Dr. Hans Barkan was called into consultation. May 10, nervehead was getting pale; secondary atrophy had occurred; eye was blind but had good movement. Bad visual result was obtained as operation was necessary before visual changes had taken place.

CASE 2. Male J., aged 54 years, complained of swelling of right eye. He was seen on August 6, 1935. History: 4 weeks previous, the right eye became very tender and painful especially in the forehead region. He saw a doctor at this time to have his glasses changed. No drooping of right upper lid was noticed until observation of picture 7 years ago. Examination disclosed vision 20/20–4 in the right eye and 20/20 plus in the left. Upper lid was swollen and edematous—exophthalmos. Eyeball was pushed down and out. Eye grounds were entirely normal. Diplopia was present but worse up and down. He was referred immediately to Drs. McClure and Keeler who made a diagnosis of chronic right frontal and ethmoiditis at that time. Conservative treatment of the nose was started, and on August 7 a large polyp was removed from the middle meatus, followed by a profuse continuous drainage. Both antrums were opened. On August 8 radical Killian procedure was advised. On September 3, the usual Killian incision was made and the anterior wall of the frontal sinus was found to be definitely infected. This

was removed and the cavity was found to be filled with pus under pressure and to contain considerable granular tissue. The dura was exposed and was found to be covered with granular tissue over an area of about 3 by 4 centimeters, the whole posterior wall of the frontal sinus having been destroyed. The anterior wall and the floor were removed entirely and the granulation tissue curetted away as far as possible. The ethmoids were then opened anteriorly and a large amount of free pus was again found under pressure in the posterior ethmoidal region. The ethmoidal labyrinth was completely exenterated and the middle turbinate was removed. Satisfactory drainage from the frontal to the nasal cavity was obtained, except that there was such an extensive necrosis that it was not possible to retain a bony canal. The whole medial wall of the orbit was removed, and at this time a large amount of foul smelling pus was found. The wound was packed to the nose, with vaseline gauze. The anterior incision was closed in the usual manner, and a wet dressing was applied.

Diagnosis: Chronic right frontal sinusitis with extradural abscess. Chronic right maxillary sinusitis and ethmoiditis. Orbital cellulitis and phlegmon.

Eye examined October 26 showed vision 20/16 in each eye. Eye grounds were entirely normal; there was no exophthalmos, and no diplopia. Visual fields were normal.

CANCER OF THE LARYNX[1]

W. E. SAUER, M.D., F.A.C.S., St. Louis, Missouri

In my discussion only the intrinsic cancers of the larynx were considered. A brief review of the history of cancer of the larynx was given, with a comparison of the results obtained in the treatment of cancer in other parts of the body. The question of the increase of cancer in general and of laryngeal cancer in particular, was discussed, together with the possible influence of smoking. Alteration of the voice as an early symptom of intrinsic cancer was pointed out, and the disregard of this symptom by both the laity and physician was deplored.

The difficulties of diagnosis in the early cases were stressed, together with the value of careful clinical observation, but the final proof that a growth is malignant and the degree of malignancy must be made through the aid of the microscope.

The dangers of stimulating the growth and producing metastasis by removing portions of the tumor has not proved to be as grave as was formerly believed. Attention is called to mistakes made in diagnosis from poorly collected specimens. The pathologist's report should always be backed up by the clinical findings.

The curability of early cancer of the larynx, when the growth is confined to one vocal cord, varies from 75 per cent to 84 per cent. Unfortunately, less than 20 per cent of the cases present themselves for examination when such results are possible.

The 3 methods of treatment are: (1) removal of the growth through laryngofissure; (2) complete removal of the larynx; (3) radiotherapy. The choice of treatment depends upon the individual case, the location and extent of the lesion, and the degree of malignancy.

The mortality following the operative procedures, owing to pre-operative care and refinements of technique, has been reduced from 50 per cent to 3 per cent. The importance of the after-care, with consideration of the complications that may arise, are taken up. The value of intravenous injection of neoarsphenamin in the treatment of spirochetal infections of the wound and lungs is reported. Radiotherapy of cancer of the larynx has not given results comparable to surgical removal, and laryngologists are loath to risk their early cases to this form of treatment until more time has elapsed and radiotherapy has proved itself. Recent reports of this form of treatment offer more encouragement.

[1]Abstract of paper presented before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

A RÉSUMÉ OF ONE HUNDRED TRANSANTRO-ETHMOSPHENOID OPERATIONS[1]

CHARLES EDWARD FUTCH, M.D., F.A.C.S., LOS ANGELES, CALIFORNIA

THE problem of surgical relief of sinus disease is a challenge to each of us as rhinologists. The contributions in this field in the last decade by Lynch, Sewall, Turnbull, and Ferris Smith are monumental, but as sinuologists we must surpass our previous efforts if the prejudice of the profession and the layman is to be amended.

TECHNIQUE

I appreciate this opportunity to acknowledge my gratitude to Dr. Frederick M. Turnbull, who patiently instructed me in the technique as published by him. In the following series of cases, this technique has been my choice which, in one operation, accomplishes adequate approach, removal of the diseased tissue, and aeration. It is generally recognized that the ethmoids are the crux of success in this work. These cells are present at birth and by their anatomical nature and poor drainage are the most frequently and chronically infected. In some cases a complete exenteration of the ethmoid cells is impossible by any technique because of postorbital or pterygoid extension. As stated by Frederick Law: "Unless the surgeon has knowledge of the anatomical structure and measurements to guide him into this separate ethmoidal cell, he is liable to leave this diseased cell, and the results of operation will be unsatisfactory."

Mosher states that the incidence of ethmoid cells outside the true ethmoid capsule is only 5 per cent. This 5 per cent of the diseased cells means a 5 per cent failure if they are not removed, and this percentage, plus that resulting from surgical imperfection, is too high to result in a reasonable satisfaction either to the patient or to the surgeon.

In 98 per cent of these cases surgical antral disease was diagnosed. Frontal disease was present in only 2 per cent. In the choice of the transantrum technique, relief of the most frequent combination of pathological conditions was accomplished, and drainage of the frontal sinuses was improved in 1 operation without surgically entering the frontal sinuses.

PRE-OPERATIVE STUDY

A definite routine of study leading up to diagnosis was used in each of these cases. A history was taken and primary study made upon the first visit. If sinus disease was definite or suspected, X-ray films were ordered. As a rule, no sinus irrigations were indulged in before X-ray study, but if irrigations had been done, 3 to 4 days were allowed to elapse before the X-ray pictures were taken.

Too much stress cannot be placed upon the importance of X-ray study. The films should be taken by a roentgenologist who has made a specialty of such work. The stereoscope which is fitted with the Pancro mirrors as have been developed by Turnbull, has proved to be of great assistance in my later cases in the localization of disease.

Upon subsequent visits nasopharyngoscopy was done repeatedly, with particular attention to the sinus ostia. Irrigations of the antra and sphenoids were likewise done, isotonic sterile saline at 105 degrees F. being used. The antrum irrigations were all done through the middle meatus, approximately 85 per cent through the natural ostia, a Fletcher Pierce sterling silver cannula being used. The occasional case in which the natural ostium was not found was irrigated with the Larges semi-sharp antrum cannula. The sterling silver Brown sphenoid cannula was used in the sphenoid technique. The flexibility of this cannula made it possible to irrigate around most septal deviations and hypertrophied membranes.

The clinical findings, observations of return fluid upon irrigation, and X-ray study determined the type and degree of pathology in each case.

INDICATIONS

In this series of cases, diagnosis of sinus infection plus the constitutional picture and history were used as the basis for surgical indication. A patient with a high degree of sinus disease but with no marked constitutional reaction or disability will not appreciate surgical intervention although it may be theoretically indicated; on the contrary, a patient with only a minor degree of sinus trouble but with an almost complete arthritic, cardiac, or other disability may fail to improve with all efforts except by exenteration of the sinus disease. Regardless of the pathological condition present, except in definite polypoid or cystic degeneration, irrigations and the usual conservative therapeutic measures were carried out, and occasionally in those cases with purulent involve-

[1]Presented before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

ment and apparent metaplasias, such improvement was noted clinically and constitutionally that only conservative surgery, if any, was concluded.

In the classification of indications for radical surgery, Skillern names the "absolute and relative," and it may be of interest to note that only two of this series fell under the absolute (immediate) classification. In both of these cases the frontal sinus was trephined immediately. The other sinuses were treated conservatively at the time and were operated upon at a later date with the transantrum technique.

We may deduce without hesitancy that sinus surgery should be, and is, based upon the same principles as other septic surgery. In the more acute phases, local drainage, aeration, and constitutional treatment is sufficient, but in the chronic phases of the disease nothing less than the complete removal of the septic tissue is of avail. Quoting Proetz: "There are only two surgical objectives to be considered: the first is ventilation and drainage and the other is complete exenteration."

PRE-OPERATIVE CARE

In all cases of this series, a complete medical examination was insisted upon before operation. In the last 40 cases, an electrocardiogram was required, as in several of the earlier cases post-operative cardiac complications developed. In those cases in which the patient showed any kidney involvement other than albuminuria, a kidney function test (6 cases) was required.

Patients in which the membranes were markedly purulent were given a course of sinus irrigations in an effort to reduce the inflammation and infection before the operation. In about 5 per cent of these patients, antrum windows were made and irrigations were continued until the inflammation was reduced, as observed with the nasopharyngoscope.

ANESTHESIA

The anesthesia in the last 64 cases was greatly improved over that in the first cases by the use of avertin (tribromethanol). It has been possible by the use of this drug as a basal anesthesia for the patient to approach the operation with the minimum apprehension and for the surgeon to proceed under less pressure. This anesthesia, as used in the later cases, began when the patient entered the hospital, at which time 1½ grains of pentobarbital was given and repeated at 8 p.m. and at 6 a.m. before operation; thus assuring the patient a restful night and resistance to cocaine poisoning. Twenty minutes before operation, the nose was packed with thin pledgets moistened with equal parts of 20 per cent cocaine and 1:1000 adrenalin, applied to each of the meatuses. Immediately following this local application, the avertin was administered by an anesthetist skilled in its use, and the patient was taken immediately to the operating room where the block injection, according to the Turnbull technique, completed the anesthesia. It has been found unnecessary to inject the palatine nerves since avertin has been used. The operation was begun as soon as the injection was completed.

The chief contra-indication to avertin is organic disease of the liver, therefore in very toxic cases, the liver function test is indicated. Bilateral kidney lesions and acidosis are also contra-indications to the use of avertin. Alpha-lobelin is an active antithesis and should be kept in readiness. In the total series of cases there were no anesthetic complications or unpleasant sequelæ.

OPERATION

This paper does not deal with operative technique, but one principle should be emphasized: the removal of the nasal wall of the ethmoid capsule with the superior turbinate. I am aware of the discussed danger of opening the perineural sheaths of the olfactory nerves and the consequent possibility of meningitis. This misfortune has not been encountered, and I feel that the subsequent benefit of this procedure more than justifies the risk. This method likewise has been criticized because of the destruction of the lateral branches of the olfactory nerve, but as the septal distribution is anatomically greater and as a large percentage of these patients complain of an impaired sense of smell before operation, I cannot but again feel justified. In this series of cases, there has been no case in which the partial loss of smell has been permanently a major complaint, and several have stated an improved olfactory sense.

COMPLICATIONS

At the time of operation, hemorrhage was a complication which gave much less trouble than was expected, and no uncontrollable hemorrhage was encountered during actual surgical procedure. In the order of importance, bleeding occurred at operation from the following vessels: the anterior ethmoidal artery, the pterygoid plexus, the sphenopalatine artery, and the posterior ethmoidal artery. Hemorrhage from the ethmoidal arteries was controlled by adrenalin sponges *in situ*. In 7 per cent some bleeding persisted when the operation was completed, and in these cases a one-fourth inch phenolated vaseline packing was left over the bleeding point and removed through

the nose during the next 24 hours. In 4 per cent, the sphenopalatine artery was tied off at operation by use of the Sewall sphenoid ligature instruments. This procedure was not difficult with these instruments when the mucous membrane, with the periosteum, was dissected down from the anterior face of the sphenoid sinus. I feel that the security of this practice is well worth the short time involved.

Postoperative hemorrhage was more troublesome. In 1 case hemorrhage from the sphenopalatine artery was uncontrolled by packing, and, due to the free bleeding, ligature was impossible in my hands. The external carotid artery was tied off with immediate control. A similar hemorrhage and control occurred in 1 case 8 days after operation. In 4 cases less profuse hemorrhage occurred between 4 and 14 days after operation, all of which were controlled with packing. I no longer consider the possibility of hemorrhage as formidable as in my earlier cases.

In 2 cases there was a continuous drainage of clear fluid for 4 or 5 days after operation, both from the left side of the nose. No unusual headache or temperature was present. It was my opinion that this drainage was spinal fluid and that the dura undoubtedly had been injured at operation. Fortunately, the flow of fluid protected against infection in these cases, but such good fortune can hardly be routinely expected. In 1 case, during anterior ethmoid exenteration, the dura was exposed for an area 4 by 4 millimeters, probably due to surgical fracture. There was, fortunately, an uneventful recovery in this case.

Halle states that he has never seen an operative laceration of the dura. He has seen dehiscences exposing the dura, but he believes that such exposure is no more dangerous than similar exposure of dura in mastoidectomies.

Light shock was encountered in 3 operations; in each one during the ethmoid surgery. The operation was in each case continued after lowering the head and administering alpha-lobelin. Profound secondary shock was encountered in 2 cases in which bilateral operation was done. This experience did not always accompany the bilateral procedure, but it is questionable if such shock would have occurred had the operation been divided. In 4 cases the primary incision had to be freshened secondarily and sutured 2 to 3 weeks after operation, due to persistent fistula.

MORTALITY

At this time there has been no primary or secondary death in this series. One patient in profound shock was in a serious condition for 36 hours and showed a temperature peak of 108.2 degrees F. following a carefully matched transfusion. A subsequent uneventful recovery followed this stormy period. Halle states that in 1000 operations on the ethmoid process, he has not seen more than 1 fatality from meningitis.

POSTOPERATIVE CARE

The briefest period of postoperative care was 6 weeks and the longest period of care was 4 months. The average of this period has been 8 weeks. The longest hospitalization was 29 days and the shortest period, 8 days. The average hospitalization was 13 days. I have not felt it advisable to discharge these patients from the hospital in 2 or 3 days, as some cases have been reported. It has been my opinion that the neuralgias and the danger of a neglected hemorrhage, as well as the need of complete rest, make longer hospitalization advisable.

A 10 per cent solution of dextrose, 500 to 1000 cubic centimeters, was slowly administered to each case after operation. While in the hospital, the patients were treated every day with applications of 1 per cent ephedrine and 10 per cent cocaine (equal parts) followed with argyrol packs. Beginning the fourth day, a gentle nasal lavage was given, with normal saline solution at 105 degrees.

The average number of office visits for postoperative care was 3 visits each week for 2 weeks, then a gradual decrease in number until the patient was discharged. In justice to the operation and to the patient, we refused to state a definite period of postoperative care, as the time varied in the individual case. When discharged from regular office visits, each patient was advised to report immediately for treatment in the event of an acute rhinitis. The average number of colds after operation was much lower and the duration much shorter.

PATHOLOGY

The pathological process in each of these cases had reached a stage that resisted conservative surgical efforts and treatment. In the majority of cases the tissues seen at operation bore out the pre-operative diagnosis; in approximately 10 cases, the condition was worse than anticipated. In most of these 10 cases, however, the condition was of many years' standing and a high degree of osteosclerosis masked the soft tissue pathology, particularly that of the antra.

RESULTS IN SPECIFIC COMPLAINTS

One case of tic douloureux of 6 years' duration was relieved and has had no recurrence since

operation 2 years ago. Clinically the nose appeared clear, but transillumination and X-rays showed an old involvement. Irrigations showed foul granular pus repeatedly from the right antrum. The patient was carefully instructed before operation that our efforts were aimed at relieving her of her sinus disease, but we could not assure her of relief of the tic douloureux.

Six patients had asthma of various degrees. The 2 patients most severely affected were entirely relieved for 2 years; then 1 had a severe recurrence. Examination in this case showed some cupping and retention in the left sphenoid by the not unusual secondary cicatrix. The removal of this obstruction to drainage has given the patient much relief, although not so complete as was experienced for the first 2 years. The 4 other patients have shown some degree of improvement.

Four patients, definitely allergic, were studied and treated by the allergist. The superimposed infection of the sinus membranes persisted and surgery was concluded before the patients enjoyed a degree of nasal comfort. It has been my experience that a patient who has suffered a protracted exogenous allergy not infrequently suffers from a superimposed deep seated infectious sinusitis which does not clear up with desensitization; and, as is well known, those patients may develop an endogenous allergy to this infection. The 4 cases mentioned undoubtedly fell into this classification.

BACTERIOLOGY

In this series of cases, no original bacteriological studies were made. The rationale of surgical procedure has, however, been based upon that work done by Kistner, Rosenow and others. Upon tissues removed from hyperplastic sinuses and sent to Dr. Rosenow at Rochester by Dr. Kistner, a brief of the report was as follows: "Unmistakable organisms were found in all tissues and the bacteria were by far the most numerous in the deep layers next to the periosteum and least numerous on epithelial surfaces." Certainly the surface treatment of such tissue could be expected to accomplish little more than could be expected from external application to chronic tonsillitis.

We have had some success with the Krueger autogenous vaccine, but only in cases in which the pathological condition was not degenerative. At present I have more confidence in surgery for cases in which there is a marked pathological condition and symptoms. Vaccines, in a few cases before and after surgery, have been valuable adjuncts.

CONCLUSION

Thanks to the efforts of the pioneers in this work, to some of whom I have the honor to present this effort, our status in sinus surgery is far removed from that stated by Robert Lynch only a decade ago: "One treads with fear and trembling when thinking of the care of a condition so distressing and fraught with so much misgiving as a chronic frontal sinusitis, or even more in the chronic pan sinusitis." Rather should we proceed in confidence with that technique which serves us best to relieve our patients of a pathological process which, until recent years, was held intractable.

SUMMARY

In complete sinus surgery, the transantrum technique permits the removal of pathological processes from the antrum, ethmoids, and sphenoids at one operation. The high percentage of antral disease associated with ethmoid disease makes this approach preferable to one which neglects or defers the antrum disease until a second operation.

In each of a series of 100 cases in which the transantrum technique was used, the condition was considered surgical only after clinical and X-ray study to determine the extent and gravity of the pathological process. Surgery was carried out only when the severity and persistence of the chief complaint justified the measure.

Basal anesthesia with avertin was a valuable adjunct to the usual cocaine and block anesthesia. No complications were noted in our series.

At operation, the nasal wall of the ethmoid capsule with the superior turbinate was removed. There were no complications and no pronounced loss of the olfactory sense.

Hemorrhage was countered by packing or suture at operation, and by packing after operation. The external carotid artery was ligated in 2 cases.

In 2 patients drainage of spinal fluid was present for 4 days. No resultant symptoms were noted. The dura was exposed in 1 case with no complications.

Shock in variable degrees occurred in about 10 cases, all being bilateral cases. Unilateral operation with the second performed at an interval of 1 week is advisable rather than bilateral operation at 1 sitting.

Pulmonary embolus occurred in 1 case.

The average hospitalization was 13 days; the average postoperative care extended through 2 months.

In 1 case of tic douloureux the patient has been relieved since operation 2 years ago.

In 6 cases of asthma patients have all shown definite improvement; 1 has been entirely relieved since operation 2 years ago.

Four patients desensitized to their primary allergy were not relieved until the secondarily infected membranes were removed.

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UNIQUE SYMPTOMS AND EFFECTS OF SPHENOIDAL DISORDERS[1]

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THE sphenoid sinus, situated as it is in the center of the skull, may be in relationship with the three cranial fossæ and half of the cranial nerves and important blood vessels. It often occupies one-third of the middle fossa in the lateral diameter. When diseased, it gives symptoms which are most unexpected and bizarre. In many cases, very little emphasis is placed on the clinical picture presented by patients suffering with sphenoiditis and too little time is devoted to the otolaryngological study. Patients with sphenoiditis show numerous, perplexing, and variable signs and symptoms; and since they are often in the realm of neurology, are referred to the neurologist for diagnosis. He, in many instances, overlooks the possibility of sphenoiditis because of his lack of familiarity with the symptomatology of this disease.

Infection of the sphenoid sinus alone is probably rare but frequently the involvement of the posterior ethmoids clears up, due to their better drainage, thus leaving the sphenoids alone the sole center of disease. Of all the sinus suppurations, the sphenoid is the most dangerous because of its being surrounded by the meninges, the cavernous sinus and its contents, the carotid artery, the hypophysis, the optic nerve and chiasm. No doubt some sphenoids with a low grade infection have escaped detection for years, having been considered merely a chronic catarrhal condition until the sudden appearance of a severe ocular disturbance or another complication has invited immediate attention. In fact Vail reported the examination of 75 pairs of sphenoid sinuses removed routinely at autopsy at the Cincinnati General Hospital. All the cases were on services other than nose and throat. Five patients showed gross infection of one or both sphenoid sinuses. After going over the histories, there was nothing to suggest that there had been any suspicion of sphenoid sinus infection. Apparently the infection in the sinus was not in any way a factor in the death of the patient, but at any rate in 5 of 75 cases, there existed an obvious chronic suppurative sphenoiditis not recognized during life. McKibben, at the medical department of the University of Southern California, found the same percentage of non-detected sphenoid suppuration in the dissection room.

Since every rhinologist today is familiar with the anatomy, it is unnecessary to say anything more than to call attention to the enormous variation in size and the consequent variation in relationship which occur with this sinus. The sinuses are frequently asymmetrical, one sinus frequently occupying much more of the space than the other, at times the involvement of one sinus being so great as to involve both optic or both vidian nerves. There are always two ostia but the dividing partition may be considered as radiating to any degree like the spokes of a wheel. Dehiscences in the bony wall are often present thus placing the sinus mucosa in direct contact with the optic nerve. In several postmortem examinations, the vidian nerve lay bare in the sphenoid cavity without any bony covering and therefore subject to immediate inflammation when the sphenoid was involved. It will be recalled that the vidian nerve runs on the floor of the sphenoid sinus and any excessive pneumatization will hollow out the pterygoid plate lateral to the nerve in such a way that a deep recess may be formed. Any infection getting into such a sinus usually gravitates toward this recess and readily forms a focus of infection which is very resistant to any form of treatment.

The vidian nerve and its many ramifications are responsible for many of the symptoms which confound the clinician. The external wall is frequently the thinnest, being often the thickness of a cigarette paper with dehiscences occurring in it, especially if the sinus is large. This wall helps to form a portion of the middle cranial fossa and is in direct communication with the cavernous sinus, the outer or external wall of which contains the internal carotid artery and the oculomotor, trochlear, and the ophthalmic and maxillary divisions of the trigeminus and abducent nerves.

The optic nerve crosses the upper and lateral angle of the sphenoidal sinus. Bulson states that in cadavers which he studied, the thickness of the bony plate between the optic foramen and the contained optic nerve and the cavity of the sphenoidal sinus varied from total absence to 2 millimeters. In many cases the thin wall of the sinus was found pushed into mound-like relief by the nerve, so that in a sense the nerve passed through the sphenoidal sinus and was separated from the cavity merely by thin bone and, when osseous deficiency existed, only by the mucous membrane. He says further that the optic

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commissure is always in the roof of the sphenoidal sinus. As the ostium of the sphenoidal sinus is high up from the floor, usually about 1 centimeter, drainage often is poor, and pus may rise as high as the optic foramen before it can escape into the nasal cavity or can be confined under pressure in case the natural drainage is obliterated.

The (5) anterior wall interests us most from the surgical standpoint as it is the only one accessible to approach. Within the mucous membrane covering the anterior wall, we have the pharyngopalatine artery. This fairly large artery when torn or cut, causes frightful hemorrhages. Sphenoidal infection may take place in children; the sinus is fully formed by the fourth year. Myerson has reported a death in a child, 5 years old, from meningitis in which the sphenoid sinus showed pus.

Sphenoid sinusitis may be classified as acute and chronic. We will pass over the acute form by merely mentioning that the symptoms are similar to those of the chronic form, except that the attack is sudden; the headache, neuralgic pains, and tightness in the head are most intense, and the vertigo is pronounced. The optic neuritis may result in transitory blindness, and the field of vision and color acuity may be so affected as to produce a temporary color blindness and tubular vision. The various symptoms associated with sphenoiditis are subjective, objective, general, and ocular manifestations which vary from headaches to the peculiar syndromes, some of which are seemingly unattached to the sphenoid. The symptoms are dependent upon the type of sphenoid, the abnormal anatomical situations, and the degree of extensions of the pathological process. Of the different types, the hyperplastic is the most variable. The opinion is prevalent among otolaryngologists that many of these patients come to them with conditions previously diagnosed as neurasthenic.

Among the subjective symptoms (7) is headache from irritation of the vidian nerve and sphenopalatine ganglion, which pains are typically sensory along the distribution of the fifth nerve. They are sharp and severe (3), beginning along the side of the nose, passing into the eye, temple, ear, mastoid, back of head, shoulder, and down the arms. The headache situated in the occipital region radiates in fan-shaped formation upward toward the vertex. This pain was formerly considered as a reflex through the vertical nerves. It is very different in character from the pain in the trigeminal region and is more likely to be of vasomotor origin due to a spasm of the occipital artery. Investigation has revealed the anatomical knowledge of the sympathetic nerve fibers associated with the carotid artery and sheath: pressure exerted over this region produces or increases sphenoidal pains when this sinus is affected. Many other reflex pains associated sufficiently often add to the complex symptoms. Ridpath (4) mentions two of these: a reflex pain felt over the canine tooth on the side affected, and pain of a burning or continuous character at the junction of the soft palate with the anterior pillar of the faucial tonsil. A third is a dull, sickening pain of continuous character felt over the pyriform crest. Pain in the ear is also common and may be very severe simulating the pain of acute otitis media.

I would like to report a case in which the ear symptoms predominate.

CASE 1. Mrs. L., aged 33 years, when first seen complained of headache, deafness, pain in both ears, loss of memory and insomnia, temperature was from ½ to 2 degrees above normal almost daily. Onset of present illness began 16 months previously with pain in left ear which broke and discharged for a few days. This ear cleared up, but several months later pain developed in the right ear. There had never been any previous head symptoms except an influenza 3 years ago. Since that time the patient had had rather frequent colds and postnasal discharge. About 1 year ago, pain occurred in both ears, sharp and severe, and the hearing became worse and worse. Because of the daily temperature, her physician suspected pulmonary tuberculosis and the patient was put to bed for several months. Ears did not discharge again but deafness increased to the degree that she could barely hear ordinary conversation.

Headache. Throbbing pain in vertex was made worse when she stopped over. The pain was referred to the ears and seemed deep seated. She had consulted several physicians and head specialists with no relief, and with varied diagnoses. Ear inflations did not improve deafness. Because of the long duration of symptoms and the fact that the patient lived out of town, she was admitted to the Good Samaritan Hospital for diagnosis. The following pertinent facts were found during her sojourn in the hospital: daily temperature 99 to 100.5 degrees; leucocytosis from 10 to 11 thousand; blood and spinal Wassermann negative, as were examination of chest, urine, and stools and neurological examination of cranial nerves. Roentgenographic study of the skull, sinuses, and mastoids showed nothing suggesting pathological change in the skull proper. The sphenoid was about half pneumatized in the anterior portion; the sella was normal in appearance; nothing suggestive was seen in the vault. The mastoids were normal throughout. Roentgenograms of the sinuses showed normal appearing symmetrical frontals, also normal appearing ethmoids and left antrum. The right antrum showed definite thickening and roughening of the wall. There was a definite fuzziness in both views made of the sphenoid in the Granger line. X-ray conclusion was bilateral sphenoid pathology.

Otolaryngological study. Weber test revealed bone conduction to right and less than normal. Hearing for conversation, one-third of normal in right and one-fifth in left. Loss of hearing for both high and low tones was in about the same percentage. Both membranes were thick and

definitely retracted. There were no perforations. Tenderness was noted over both mastoids. Other cranial nerves were found normal. Cerebellar tests gave normal reaction. The tonsils had been well removed, but there was a small amount of mucopurulent discharge on the postpharyngeal wall. Both middle turbinates hugged close to the septum. Probing and washing the sphenoid always caused severe pain in the ears, the same pain that the patient complained of continuously. Both sphenoids were opened under local anesthesia after removal of the posterior halves of both middle turbinates. The membrane was found to be thick and polypoid and purulent material was removed.

Convalescence was satisfactory in every way. The sphenoids were washed until the discharge disappeared. Improvement in hearing was almost immediate, and the patient was delighted that she could hear the radio in an adjoining room as well as sounds which she could not hear before. Within 2 months hearing was improved 100 per cent in both ears without other treatment. The temperature became normal as did the leucocyte count, and all pain disappeared.

This case is interesting as the patient had been in bed for several months because of fever. She had been advised to have a mastoidectomy because of pain. She had such severe pain in the ears that she required narcotics daily for several months. Her symptoms were all referable to some other place than the nose, except for a slight postnasal discharge and yet the symptoms all disappeared when the sphenoids were opened and drained.

Frequently conditions of the eye or in vision are the causative factors in referring patients to a rhinologist. Much confusion has arisen in the past as to what causes of choked disc are the result of mechanical factors and what ones are the result of swelling of the nerve head due to toxic sources. It is admitted that the most frequent cause of papilledema is an intracranial lesion. However, the case reports of competent observers would seem to bear out the fact that marked papilledema may be produced by factors other than a serious intracranial lesion, for instance by a purulent inflammation of the sphenoidal sinus. While I am opposed to undue haste in deciding to open a sphenoidal sinus and in the performance of unnecessary operations, yet I believe we are not justified in following a conservative course when the diagnosis seems fairly conclusively determined as a result of a cooperative study by the ophthalmologist, rhinologist, and roentgenologist. The possible consequences of delay are too serious to justify temporizing, particularly when the operation on the sphenoid is a relatively safe procedure from an operative standpoint. So many cases of optic involvement with associated sphenoidal infection have been reported that we will omit reports of cases of this sort. A most interesting case developed in an X-ray technician who has been under the care of my associate, Dr. Colby Hall.

CASE 2. A. S., a 22 year old girl, in June, 1934, noticed a blurring of vision. She noted that she could read well with either eye but binocular reading was impossible. Nasal examination revealed no disease. Repeated fundus examinations revealed normal nerve heads. Neurological examination, including spinal fluid, revealed no abnormality. Patient had a definite defect in convergence and accommodation, the large "F" on the eye chart being blurred or double at 20 feet repeatedly. One day she reported with an intense dull pain behind the right eye. The region of the right sphenoid ostium was cannulized to a depth of 7.5 centimeters and warm saline irrigated through the cannula. This was followed by relief of pain. No discharge was recovered. The patient called the next day and said that her vision had been normal for nearly 8 hours. The process was repeated many times with the identical result. Shrinkage of the ostium was followed by no relief. Irrigation of the nose gave no relief, and neither did treatment of the left sphenoid. The relief in vision was almost immediate before the cannula was removed. X-ray examination demonstrated that the cannula was not in the sphenoid sinus but flush against the face of the sphenoid. A few months ago the sphenoid was opened. A slightly thickened membrane was found but no discoloration. Irrigations of the sinus since then have given the same results. Occasionally the vision is restored to normal for 10 to 12 hours.

In this case there is no question of optic nerve involvement, but rather the muscles of accommodation; undoubtedly, we are dealing with a very thin external wall of the right sphenoid possibly with a dehiscence.

Time will not permit the report of more cases, but in conclusion, I would like to emphasize the importance of the investigation of peculiar syndromes in the head which are seemingly unattached to the sphenoid. The unfortunate lack of knowledge not only from the standpoint of the medical man but also from that of the neurologist and rhinologist, leaves many cases unsolved. The more this sinus with its symptoms is studied, the more one will appreciate the likelihood of its being a focus of infection.

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MANAGEMENT OF COMPLICATIONS IN THE OPERATIONS FOR CATARACT AND GLAUCOMA[1]

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SOME form of conjunctival flap, I believe, is definitely effective in the management of complications in operations for cataract and glaucoma. The principal service of the flap is not to hold back the vitreous that threatens to escape, but to prevent an eversion of the corneal flap, and to contribute to a sure, rapid, smooth, and uncomplicated process of healing.

The conjunctival flap can be more accurately fashioned before the incision is made, and one or more sutures inserted before the delivery of the lens will almost invariably maintain satisfactory relations of the lips of the incision. The most ideal results have been achieved by me when an uncut conjunctival bridge has been used. It is somewhat more difficult in execution, but it makes for safety and prompt recovery.

PROLAPSE OF VITREOUS

Vitreous loss alone in moderate amount does not preclude a good result, but if possible the loss should be prevented or reduced to the minimum. If the vitreous is known to be definitely liquefied and the choroid seriously degenerated, operation is contra-indicated. If the vitreous is normal, I proceed promptly with an intracapsular removal. I use the flat spatula of Smith which is passed down into the vitreous and serves as an inclined plane upon which the intact lens can be made to glide upward and outward when external pressure is judiciously and gently applied. This procedure when mastered is practically always successful in saving both the lens and the vitreous. It is especially important that the capsule should not be ruptured in such cases; thus leaving retained capsule and cortex to blend with traumatized vitreous, which might lead to cataract and delay recovery. Of course, it is always essential to make a correct incision. If in doubt, a shorter incision should be made with the knife and if necessary enlarged with scissors.

Anesthesia—local and general. In practically all adults, I depend on local anesthesia, according to the accepted modes of application; although I have found intravenous injections of barbituric acid salts wonderfully satisfactory, except in patients with idiosyncrasies to these agents. When the electrocautery is to be used, as in the removal of malignant neoplasms, the barbiturates are especially indicated, as inflammable anesthetics, like ether and ethylene, could not be used. The skillful administration of chloroform has many advantages and I have encountered no accidents in its employment. When necessary to supplement the bromides or barbiturates by mouth, I have found pantopon or some other morphine derivative given hypodermically to be safe and efficient.

Expulsive hemorrhage. This dire disaster cannot be foretold. It is not dependent upon increased intra-ocular pressure and not necessarily associated with arterial hypertension or vitreous loss. It seems to depend upon vascular degeneration of the choroid and may occur during, or at any time within a few days after, the operation. If large vessels rupture, the case is hopeless. If smaller vessels rupture, the hemorrhage may be arrested by elevation of the head, gentle pressure upon the closed lids, and a few whiffs of chloroform pending the action of morphine or pantopon administered hypodermically. I have seen these measures succeed. Many complications may be avoided by promptly closing the lids the moment the essential steps of the operation have been effected.

Infection—exogenous and endogenous. With thorough precautions, exogenous infections can almost be eliminated, but endogenous infections occasionally may occur in vulnerable patients. In these latter patients, injections of various proteins may be quite effective. From an operative standpoint, the uncut conjunctival bridge and reduced trauma will be the chief factors of safety.

Postoperative glaucoma. The measures of supreme importance in preventing and in controlling this complication are keeping the inflammatory exudates away from the filtration angle; quick union to prevent epithelial proliferation within the anterior chamber; avoidance of after cataract with the consequent needlings; and the judicious regulation of mydriatics and miotics with careful systemic attention. Needling involves quite as much hazard as the original extraction because this means excitation within the closed eyeball without the safety of drainage.

Epithelial ingrowth. The greatest safeguard against this complication would be an adequate conjunctival bridge insuring a speedy closure of the incision.

Retinal detachment. The prevention of retinal

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detachment is in the elimination of excessive vitreous loss and of chronic uveitis with a softening of the globe. The cure, if possible, depends on one of the modern surgical procedures, combined with rest and judicious local and systemic management.

Sympathetic ophthalmia. This complication, so far, I have encountered once after careful cataract extraction and once following a smooth Elliot trephine operation, but it has occurred many times in better hands than mine. Our great master in ophthalmic surgery, Herman Knapp, of New York, has reported an average of 1 case of sympathetic ophthalmia in every 750 of his cataract operations. The unrivaled pioneer ophthalmic surgeon, Albrecht von Graefe, encountered this disaster so often in his modified linear extraction that this particular method was largely abandoned.

The prevention would be in avoiding those factors that favor a prolonged iridocyclitis with a non-suppurative weeping eye. In suspicious cases, the measures advocated years ago by our honored confrère, Harold Gifford, of Omaha, still stand pre-eminent.

Iridectomy. What to do with the iris has always been an important question. The dictum enunciated long ago by that princely surgeon, Henry Power, of St. Bartholomew's Hospital, London, embraces a golden truth: "When no complications are threatened, a round pupil is best, but when difficulties or dangers are encountered, perform an iridectomy."

A more extended consideration of the use of the undivided conjunctival bridge in operations for cataract and glaucoma. This phase of the subject relates to the employment of the uncut conjunctival bridge, which is an ancient and well established objective. The literature on ophthalmology reveals that at different times this subject has received the serious consideration of many leading men, among whom are some of our pioneers in ophthalmic surgery such as Desmarres, Sr., Terrien, Vacher, Pansier, Bajardi, Lundsgaard, Cridland, and Harrison Butler. We would not hope to add any new principle in ophthalmic surgery, but only to develop a method of procedure that would utilize the possible factors that make for security and speedy recovery. I shall try to describe this method in a few words.

With special conjunctival fixation forceps, the conjunctiva and subconjunctival tissues are grasped firmly above the cornea and extending from 4 millimeters above the limbus to the region of the equator. The bridge should be about 12 millimeters in width and should have sufficient subconjunctival tissue to insure strength and nutrition. With the forceps, upward traction is exerted on the globe. This gives perfect fixation of the eyeball and at the same time reduces the tension, which is desirable in preventing the iris from falling forward on the knife during the transfixion. In steadying the eye, this technique does not tend to make the incision open or gape as is often the case when pressure is applied below the cornea. In fact the effect is similar to that of a superior rectus suture but is more manageable in determining the direction and extent of its action.

Moreover, the vertical fold of the conjunctiva above the cornea held in the grasp of the fixation forceps facilitates the formation of the desired bridge by the cataract knife after it emerges through the sclerocorneal incision. The bridge can be made wholly with the knife, or it can be supplemented with scissors, or it can be fashioned entirely before the incision is made, or it can be modified, broadened, and shortened in glaucoma cases. The procedure will be more accurate if the knife incision includes only the upper third of the limbus arc, the wound being extended on either side with scissors so as to include a narrow band of conjunctiva 1 millimeter in breadth.

A matter of considerable importance relates to the judicious handling of the bridge, which can be used in all forms of cataract operations as well as in the various operations for glaucoma. I have endeavored in many ways to regulate the influence of this bridge upon the size and pliability of the sclerocorneal opening. If a good bridge is fashioned, left alone, and the patient is directed to look down, the value of the bridge is, in a measure, nullified because the bridge tightens down on the globe and closes rather firmly the opening through which the lens must pass. If the patient looks straight forward, the lips of the sclerocorneal wound still remain in apposition. Therefore, the bridge must be elevated by some means in order to gain the adequate space desired. If the bridge is elevated by any kind of hook, both the corneal and the bulbar segments of the bridge will be rendered equally taut and there will be imparted to the incision a certain rigidity which is incompatible with facility in the lens delivery. If the bridge is lifted by means of a thread passed under it, the same conditions of tension are produced. By each of these procedures, the bridge can be drawn aside so as to give free access to the iris for iridectomy or iridotomy, but the objectionable feature of rigidity is still maintained which favors rupture of the capsule at the moment of the delivery of the lens.

There is, however, one procedure which will

secure perfect relaxation of the corneal segment of the bridge with perfect access to the iris and lens and with the minimum of rigidity. This is accomplished by taking into account the marvelous elasticity and extensibility of the bulbar conjunctival membrane, as is done in pterygium operations. It is made in this way: With special conjunctival bridge control forceps the entire bridge is grasped firmly at a point opposite the insertion of the superior rectus tendon and the bridge is dragged forward so that it folds over the cornea in a perfectly relaxed condition, or can be elevated to any desired extent whenever the occasion demands it, or can be drawn in any direction necessary adequately to expose the iris and lens, and yet without introducing the factor of rigidity. Moreover, with the firm grasp of the upper bulbar segment of the bridge with its connecting epibulbar fibrous tissues, the downward rotation of the eye ball which can be steadied now in any required position, is permitted.

Thus we command the doorway to the interior of the globe, and this we can open or close at will, thus facilitating the necessary instrumentation under direct inspection and affording at the same time immediate closure of the wound if any untoward complications should threaten or develop.

The very instant that the lens is delivered, the lids can be closed and the eye ball can be left in its normal relations, these being the conditions most favorable for its safety. Then, after a little period of rest, if needed, the toilet of the eye can be given any attention which may be indicated. No stitches are to be inserted and removed. No inversion or eversion or maladjustments of flaps are possible. The nutrition of the cornea is not even for one moment interrupted and the process of healing can proceed with accuracy and without delay. By these measures, we are able to secure the greatest possible protection against infection, hemorrhage, vitreous loss, delayed union, iris prolapse, epithelial proliferation in the anterior chamber. Thus we are able also to secure the minimum detention in the hospital and the greatest comfort and freedom throughout the period of recovery.

SURGICAL TREATMENT OF STRABISMUS IN RELATION TO ORTHOPTIC TRAINING[1]

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THE subject of orthoptic training is of interest to all doing ophthalmic surgery. We are at present in the midst of another cycle or revival of this form of treatment for strabismus and heterophoria. Unlike previous cycles, however, I believe that this time orthoptic training has come to stay because it is being carefully evaluated and established on a firm scientific basis.

Surgical treatment of strabismus was originally designed mostly for cosmetic improvement. With advances in the differential diagnosis and surgical procedures, restoration of function seems to have become the dominant purpose in the treatment of strabismus. Orthoptic training seems to be the connecting link between cosmetic surgery and restoration of normal function or real cure.

In the general consideration of orthoptic training, the question naturally arises by whom and where it should be carried out. Inasmuch as it involves an understanding of psychology, physiology, and pathology, and is quite closely related to surgical treatment, it seems to belong in the sphere of medicine, particularly ophthalmology. The ophthalmologist, however, already is a busy man. Can he find the time necessary to devote to this added burden? Not without assistance, I believe. Neither does it seem that this orthoptic treatment should be turned over to non-medical fitters of glasses who are untrained in the necessary fundamental sciences and who, without supervision, might exploit this very necessary form of treatment. The problem seems to have been solved by the development of carefully trained technical workers who carry out treatment under the supervision of, and in co-operation with, the ophthalmologist interested in the problem.

The question arises, of what value is orthoptic training? A careful review of the literature produces quite sufficient evidence to justify the opinion that orthoptic training is worth while in the treatment of strabismus; one has but to point to the contributions of Maddox, Pugh, Cantonnet, Filliozet and Beaumont abroad, and to the work of Wells, Berens, Hardy, Stark, Guibor, Hicks, Hosford, and others in this country. In connection with the actual training, the question is often asked how long it should be continued. The answer, it appears, is that it should be continued as long as satisfactory and definite progress is being made. The value of orthoptic training in any given case cannot be established in a few months. In some of our most successful cases at the clinic, patients have been trained continuously for several years. One particularly successful result that I have in mind was obtained after 3 years of intensive training, during which there were periods of marked relapse. In selected cases and under favorable circumstances, training can be carried out from 3 to 5 years with good results. In most cases, however, operation should be performed much sooner than this, and further training should be given subsequently.

There is a natural tendency, once training is started, to hang on stubbornly past the point where surgery should be performed. I believe that early operation is indicated in many instances. The ideal procedure in any given case would seem to be a preliminary period of orthoptic training, then operation, and finally, further training. Too often after a successful operation has been performed and the eyes appear to be straight, the family and the surgeon lose interest and further treatment is not given.

The objectives of orthoptics are seen as the overcoming of suppression, the avoidance of false projection, the development of simultaneous macular perception, fusion with amplitude, and finally, stereopsis. Apparently no consideration is given to the limitations of treatment because of the patient's age. Cantonnet and Filliozet were of the opinion that it could be carried out successfully even up to the age of 35 years. Without doubt, however, the younger the patient when training is attempted, the better and easier are the results likely to be obtained.

In discussing some of the relationships between surgical treatment and orthoptic training, the question naturally arises as to when to operate. Savin might well have opened this discussion when he stated that surgical measures under modern conditions and with modern needles and instruments, could be carried out safely at any age over 3 years. He also thought that cosmetically successful operations should be followed by further orthoptic training. Griffith saw the pendulum swinging rapidly toward earlier operation when non-operative measures, reasonably tried,

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failed to produce results. Maddox (12) thought operation desirable when other measures seemed to have failed, and particularly if the time involved seemed to jeopardize the brain eye, and this regardless of the youthfulness of the patient. His youngest patient was 16 months old. So far, at the clinic, the youngest patient was 3 years old.

Hine, while objecting to operating with the patient under general anesthesia because of difficulty in watching the eyes, felt that if treatment was delayed until after the age of 7 years, the chances for recovery would be remote. The answer to this seems to be, "why delay so long?" Davis made the point that it was most important to effect a cure at a pre-school age by means other than with glasses, that is, by orthoptic training or operating, thus avoiding the mental trauma of strabismus and the wearing of glasses. The age of the patient, then, no longer seems to be the determining factor in the problem of when to operate. We must depend rather on the degree and nature of the strabismus, the condition of the visual apparatus, and the response or lack of response of the latter to training. Feasibility and availability of the patient for training naturally must be considered.

When large deviations have to be dealt with and there is no opportunity to try orthoptic training, it would appear sensible to straighten the eyes surgically and give parallelism a chance. I have seen fusion develop spontaneously in both adults and children following operation when no training had been given. Certainly this is better than merely to dismiss the patient with a pair of glasses. Failure to respond in a reasonable length of time to refraction, occlusion, and orthoptic training, properly carried out and sufficiently tried, seems to be the prime indication for surgical intervention. Just what constitutes a reasonable length of time seems in the light of present opinion to be 6 months to a year. Surgery should be resorted to if there is a tendency to relapse from the point of view of either the strabismus or amblyopia, and also if excessive contracture of the muscles continues unabated and the opposing muscles appear to be weakening.

In the persistently refractory case in which a vertical deviation is present, probably it is best in most instances to correct the vertical deviation surgically. The eyes then will often proceed toward cure. Having made progress up to a certain point with training, and then being unable to continue or sensing lagging interest on the part of the patient and his family, operation would seem to be the next step. In high degrees of strabismus, after having obtained good vision and simultaneous perception by training, operation by reducing the angle of the strabismus would seem to save valuable time. This is then to be followed by further training. As Berens has said, it is important to operate in all cases in which the condition does not respond to non-operative measures and put the eyes in a position in which they may be able to respond. Hine called attention to the group of strabismic patients whose eyes remain straight while stimulated by training, but which in the ordinary course of life return to their former state. These patients, he felt, should be operated on.

The indications for orthoptic training seem to be quite definite. To determine in any given case whether surgical aid is necessary, orthoptic training should be tried as soon as vision is compatible with fusion. Current opinion places this vision at about 6/12. At the clinic, however, we have 1 case in which fusion is perfect, with stereopsis, vision being 6/15. As a preliminary to operation, all agree that, where feasible, fusion training is essential. The ability to possess simultaneous perception, corresponding retinal congruity, and some degree of fusion certainly insures a much brighter outlook for successful surgery. After operation has been performed, the ensuing stage of muscular disorganization during which so frequently the patient is dismissed, would seem to be the time pre-eminently suited for the employment of orthoptic training. Above all others, it is probably the time when there is the best chance of restoring normal function and ultimately bringing about a real cure. Gifford called attention to the early intermittent evanescent type of strabismus in children. In these cases, he believed that training should be started before the condition became established. This appears to be a most excellent suggestion.

False projection runs high in cases of alternating strabismus. Pugh found it in 77 per cent of cases, but in my experience this seems rather high. Alternating strabismus with false projection is, however, the least amenable to any form of treatment. The argument against straightening alternating strabismus with false projection surgically is, of course, that persistent diplopia may result following operation. In our experience at the clinic, alternating strabismus has been amenable, as a rule, both to training and surgery. I have encountered temporary diplopia, lasting from a few days to several weeks, in many cases following operation. Except in 2 instances, however, the diplopia finally disappeared and the result was satisfactory. It seems probable that, when alternating strabismus with false projection

is corrected surgically, one of several things may occur: (1) there may be true projection and fusion at once, although this seems rather uncommon; (2) there may be a period of disorganization, with gradual adjustment to some degree of fusion; (3) there may be a condition of pseudobinocularism, or alternate suppression, which is probably the most common occurrence; and (4) there may be a continuation of the false projection with persistence of the diplopia. I believe this last occurs rarely. If more patients with alternating strabismus were intensively trained after surgery, the result might be surprisingly good.

Although discussion of the surgical procedures is not within the scope of this paper, I expressed the point of view in a recent paper that possibly the best surgical results might be obtained after a very careful and refined differential diagnosis had been made, with selection from all the various surgical procedures of that combination best fitted for the case at hand.

In comparing the results of orthoptic training and operation in the treatment of strabismus, it would appear that one is as important as the other, and if to these forms of treatment are added proper occlusion and accurate refraction, 4 weapons will be at hand for the combating of strabismus. It is difficult, indeed, to say which of the 4 is the most indispensable. The maximal results should be obtained through the combined use of all of them, if properly performed and in correct sequence. Operation should rarely be performed before refraction, occlusion, and orthoptic training have been given a reasonable trial. On the other hand, one should not attempt to carry training past the point where it loses its effectiveness. When there are indications for surgical treatment, operation should be performed at once regardless of the age of the patient.

SUMMARY

Restoration of function seems to be the dominant purpose in the treatment of strabismus, and the connecting link between cosmetic surgery and restoration of normal function appears to be orthoptic training.

Proper occlusion, accurate refraction, intensive orthoptic training, and selective surgery are the means at hand for the combating of strabismus. All are of equal importance, and the maximal results should be obtained through the combined use of all in proper sequence.

At the clinic, orthoptic training sufficiently and properly applied in selected cases has been of definite value in the treatment of strabismus.

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A BRIEF CONSIDERATION OF THE HISTORY OF THE DEVELOPMENT OF MASTOIDECTOMY[1]

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ALTHOUGH really an otologic subject, mastoidectomy itself was developed to a very large degree by the work of a number of general surgeons. It has seemed to me both proper and interesting to mention some of the factors regarding various developments which either antedated the actual mastoid surgery, or had no direct bearing upon it, but are important milestones in the history of otology. Among these items is that of the aural speculum, the first use of the Eustachian catheter and first paracentesis of the drum membrane (myringotomy).

Although the employment of the aural speculum has been attributed to Guielmus Fabricius Hildanus (1560–1634), it is likely that the priority belongs to an earlier name, for Guy de Chauliac (1300–1368)—(the Father of Surgery) mentions the use of the ear speculum. Systematic anatomical study which had remained almost in abeyance since the time of the Greeks, was revived in the 16th century by Vesalius (1514–1564), Eustachius (1510–1574), and Fallopius (1523–1562). This work was continued in the 17th and 18th centuries by men such as Valsalva (1666–1723), Morgagni (1682–1771), and Scarpa (1747–1832).

A non-medical man, the postmaster of Versailles, Edme-Gilles Guyot (1706–1786) endeavored to cure himself of impaired hearing by inflation of the tympanum by means of an instrument introduced through the mouth in the vicinity of the orifice of the Eustachian tube. Paracentesis of the drum membrane (myringotomy) was apparently first carried out by the great English surgeon, Sir Astley Cooper (1768–1841). He observed several cases in which the drum membrane was perforated or destroyed without causing serious hearing impairment, and therefore, thought it probable that deafness due to Eustachian tube obstruction might be relieved by puncturing the tympanic membrane.

With regard to the direct development of the actual operation on the mastoid process, it has been claimed by some that Ambroise Paré (1510–1590) was the first to perform mastoidectomy. As a matter of fact, from all the evidence I can gather (and in this I am supported by Dr. Frances R. Packard whom I consider the authority on Paré in this country), Paré does not anywhere state that he even suggested operating on Francis II for his mastoid condition.

The first successful mastoid operation for suppurative disease was performed in 1736 by Jean Louis Petit (1674–1750?), who was the foremost surgeon of his day. Owing to various factors, not the least of which was the fatal result of the mastoidectomy performed on Baron Dr. von Berger, physician to the King of Denmark, the operation fell into disrepute. Two of the great English aural surgeons, William R. Wilde (1815–1876) and Joseph Toynbee (1815–1866) were among those who also expressed themselves adversely with regard to the opening of the mastoid process. It was due largely to Anton F. von Troeltsch (1829–1890) that the German surgeons were stimulated to further work with reference to the mastoid operation. Herman Schwartze (1837–1910) did a tremendous amount of work in connection with operation of acute cases of mastoiditis and did the first of this kind in Germany in 1863. The first mastoidectomy performed in the United States was by Lawrence Turnbull (1821–1900). He was born in England but lived most of his life in Philadelphia and there did most of his work. The first mastoidectomy performed in England was by James Hinton (1822–1875) in 1868, and was reported in an address before the Royal Medical and Chirurgical Society in London.

If there were intracranial complications in acute cases, or if chronic otitis media was present, it was found necessary to develop a more radical operation, namely the radical mastoidectomy. This procedure was really the work of two general surgeons: Ernst Kuester (1838–1930) and Ernst von Bergmann (1836–1907), both of whom presented the subject before the German Medical Society in 1888 and 1889. While Kuester was the first to remove the posterior wall of the bony canal, and Bergmann was the first to remove the outer bony wall of the attic, by their combined procedures the various cavities in the temporal bone, namely the antrum, attic, middle ear, and external canal were converted into one cavity. Several modifications of the original Kuester-Bergmann operation were later developed. E. Zaufal (1837–1910) further modified the radical operation by working forward from the antrum to the attic, and by the incision of the upper and posterior portion of the membranous meatus. Ludwig Stacke (1859–1918) advocated opening the mastoid bone from within outward. After elevating the skin and periosteum from the posterior and superior walls of the bony canal, he first entered the tympanic cavity, then the attic, and finally the antrum. Later various types of plastic flaps, skin grafting, etc. were developed, but the essential principles of the radical mastoid operation are still continued to the present time.

[1]Abstract of paper presented before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.

SURGICAL APPROACH TO THE NASAL ACCESSORY SINUSES[1]

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VARIOUS methods of surgical approach to the nasal accessory sinuses have been found useful in our practice.

In dental antritis, extraction of tooth followed by irrigation of antrum by the rhinologist, not by the dentist, we have found most satisfactory. The alveolar opening is allowed to close. If the irrigating fluid is still positive after 8 or 10 lavages, lipiodol may be instilled. If there is present a filling defect and the secretion is still fetid, a radical antrum operation is given careful consideration. If no filling defect is present, the intranasal antrum operation may be the method of choice.

In cases in which the antrum cavity acts as a reservoir, lipiodol will show no filling defect. In these cases the ethmoid cells are removed intranasally as well as the greater portion of the middle meatal antral wall but preserve the middle turbinate, if possible. If a filling defect is present, the antrum is explored before the intranasal ethmoid operation is done.

In polyposis, with the antrum and ethmoid cloudy, the radical antrum, intranasal ethmoid operation is indicated; if necessary the external ethmoid, frontal and sphenoid. The external frontal operation is done only as a last resort in many instances. The lipiodol test is usually not necessary inasmuch as the antrum is generally found to be involved in cases of polyposis with cloudy skiagram.

In the presence of dentigerous and other cysts of the antrum, the radical antrum operation is indicated.

When the nasal findings are negative, the skiagram negative, and the lipiodol test shows no filling defect; when the patient complains of fullness in the cheek, exploration of the antrum through the facial wall is the method of choice. In these cases we have many times found pathological changes in the recesses with edematous swelling of the mucous membrane in the region of the normal ostium.

In the presence of antrum suppuration, with no filling defect, the germ many times being anaerobic, the intranasal antrum operation is performed for ventilation.

In serous inflammation of the ethmoid, the intranasal ethmoid operation is used. The external operation may be done later if the patient is not relieved, and if the X-ray film shows lateral prolongations of ethmoid cells into the roof of the orbit. Exploration of the antrum is carried out, if there is any doubt as to the presence of pathological changes in this cavity.

In suppurative ethmoiditis, the intranasal operation is done. If pus exudes from the nasofrontal duct at the time of operation, the external frontal is immediately done. There is less danger of osteomyelitis as a complication if this is done.

If no pathological changes are found in the nose, if bulla ethmoidalis is noted in apposition with large uncinate cell causing closure of nasofrontal duct (vacuum headache) the intranasal frontal operation is performed.

At the time of the ethmoid operation, the region of the sphenoid should be examined. If this cavity is found diseased, or if the normal ostium is closed by thickening of the anterior wall, the sphenoid operation should follow. If the lining membrane of the sphenoid cavity is found involved, it is carefully removed.

In the presence of an upward displaced infundibular cell causing closure of the nasofrontal duct and if it is impossible to open the nasofrontal duct satisfactorily in doing the intranasal operation, the external ethmoid procedure may be indicated.

The radical external frontal operation is indicated when intranasal operative measures have failed to relieve patient of headache.

The radical frontal sinus operation is indicated in the presence of orbital, intracranial complications, or osteomyelitis.

In the fulminant type of infection, conservative means should be used for a few days, and if no relief is obtained the radical ethmofrontal operation should be done.

If "silent osteitis" is suspected in the alveolar region, a dental surgeon should be consulted. If the sphenoid bone is involved with osteitis, the entire anterior wall of sphenoid is removed. A latent osteitis of the frontal bone should not be operated upon unless symptoms demand.

A thorough analysis of each patient should be made before operative steps are undertaken, and an attempt must be made to determine which cell is the chief offender, or whether the discharge is originating from an involvement of a combination of cells. It cannot be too strongly emphasized that all sinuses found diseased should be surgically approached at the first operation, if possible.

[1]Abstract of paper presented before the Clinical Congress of the American College of Surgeons, San Francisco, October 28–November 1, 1935.